Web Service-based Vegetation Condition Monitoring System - VegScape

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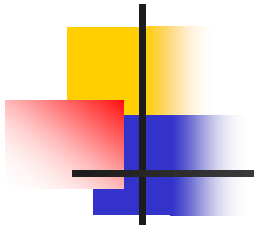
Project Goals

- Improve the science, objectivity, robustness and defensibility of nationwide crop vegetation condition monitoring operation at NASS
- Develop an operational National Crop Condition Monitoring System (NCCMS) - VegScape
- Produce crop vegetation condition data products that are complementary to existing NASS crop condition products.
- Enhance data accessibility, interoperability, online analytics, and dissemination.
- =>Meet user's requirements.

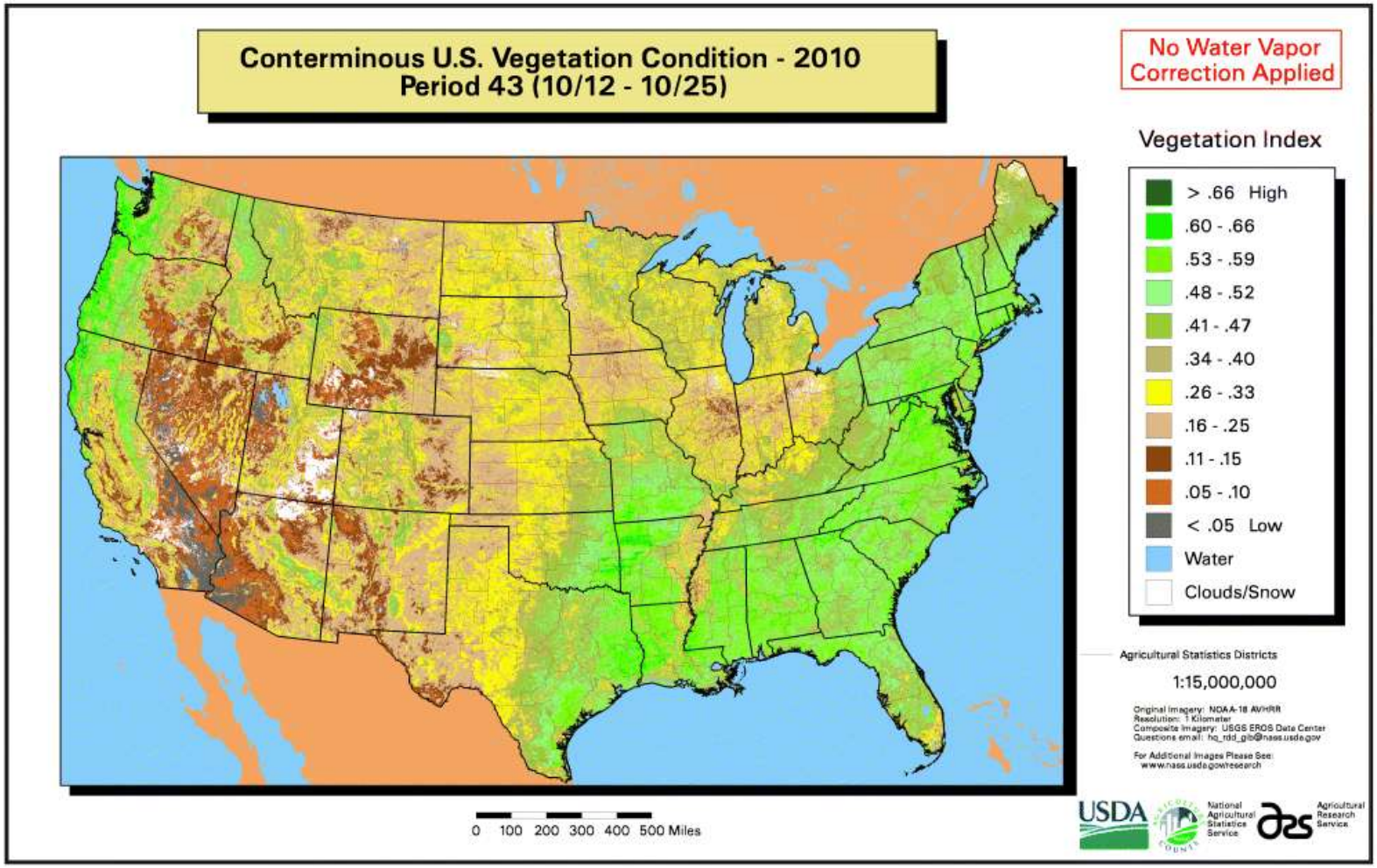
Why Do We Need A New Crop Vegetation Condition System?

- AVHRR sensor
  - AVHRR 17 – Dead;
  - AVHRR 18 – Aging, and not consistent with AVHRR 17.
  - Low spatial resolution (1km)
  - Low temporal resolution (biweekly)
- NASS weekly publishes NDVI low resolution static map; NASS needs:
  - better spatial and temporal resolutions;
  - data processing and web publishing automation;
  - better visualization and data dissemination;
  - vegetation condition analytics & assessment.

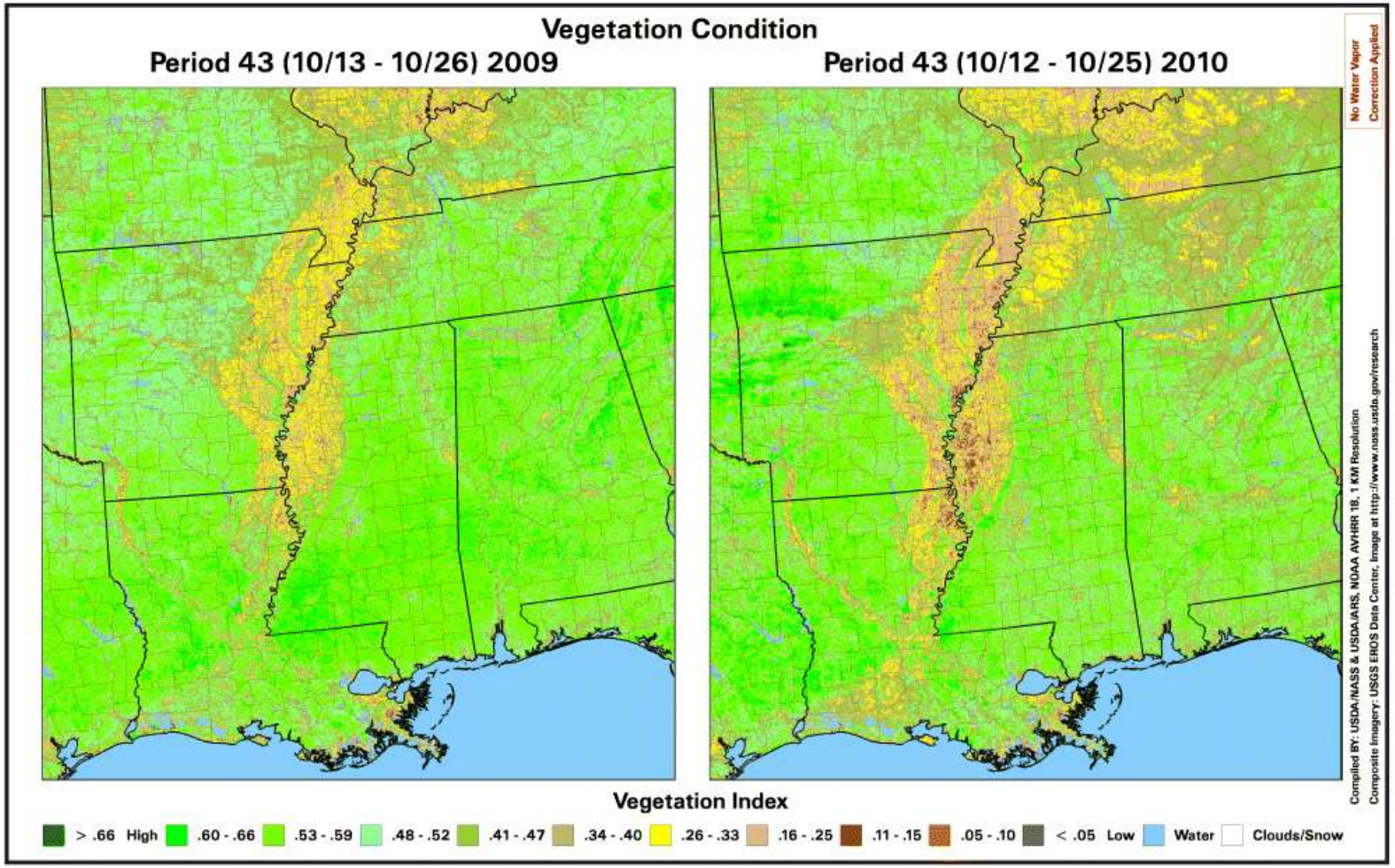


OLD VEGETATION MONITORING

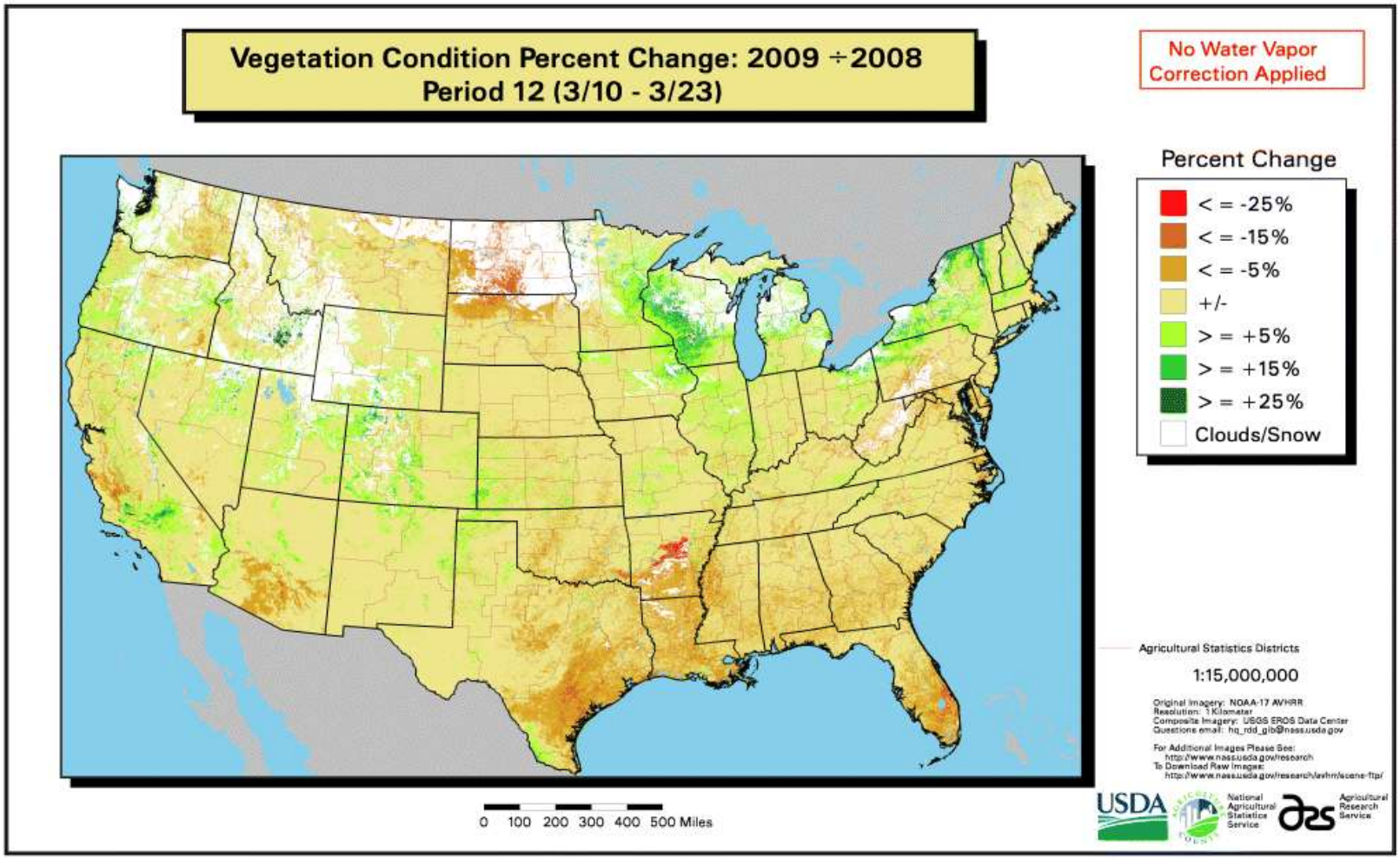
Static Crop Condition Image (NDVI)



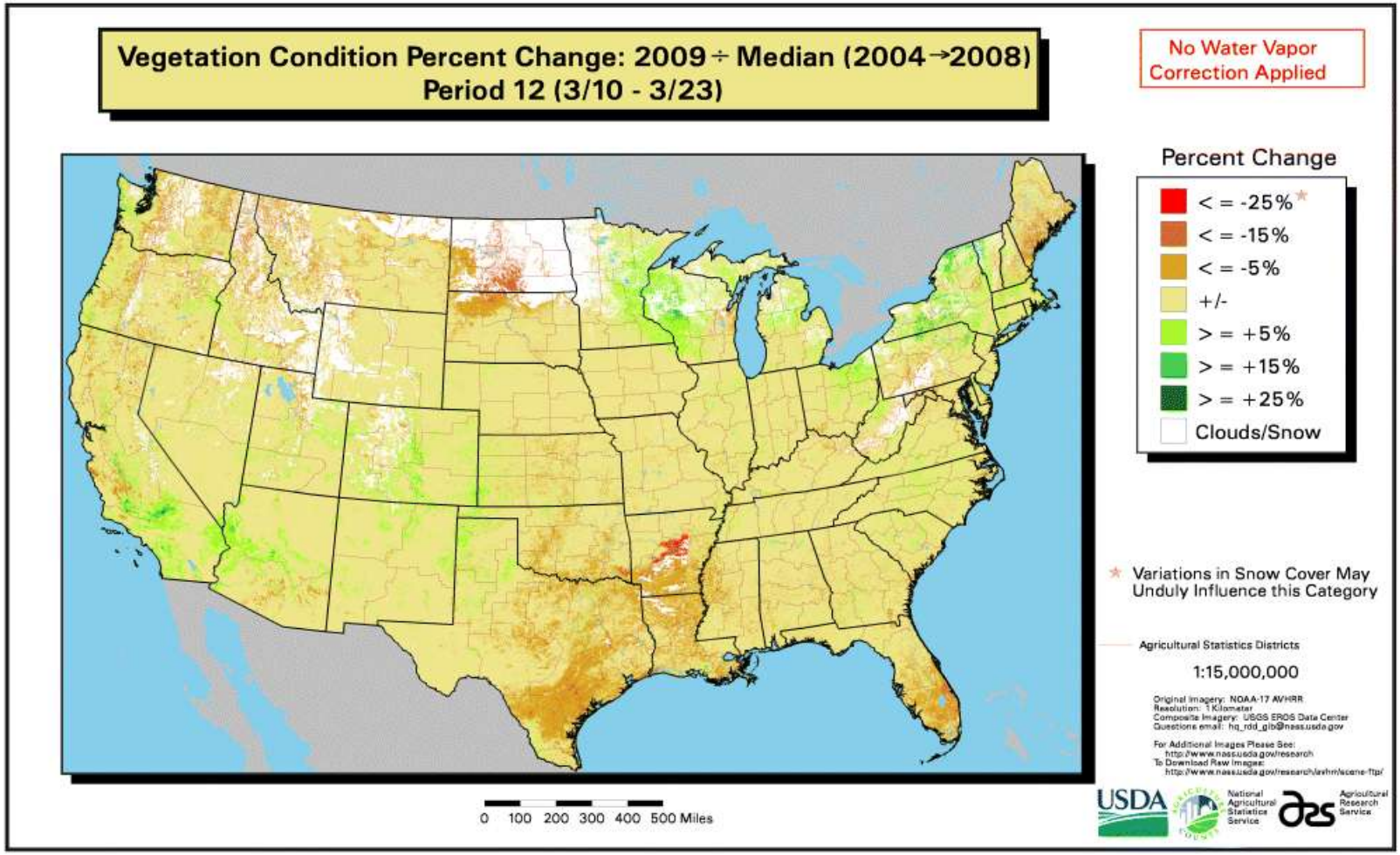
Yearly Comparison (Ratio to Previous Year)

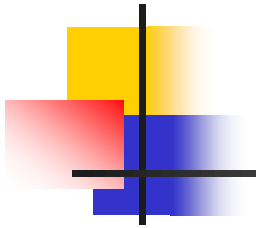


Ratio Comparison to Previous Year in Percent



Percent Change Ratio to Median





VegScape Design & Implementation

User's Major System Requirements

- Interactive vegetation condition mapping.
- Pixel-level level granularity.
- On-the-fly data processing and presentation.
- Online analytics within user defined region.
- Geospatial query capability.
- Crop specific vegetation condition information.
- Equal accession and dissemination via spatially enabled Web-based system to facilitate equal information access.

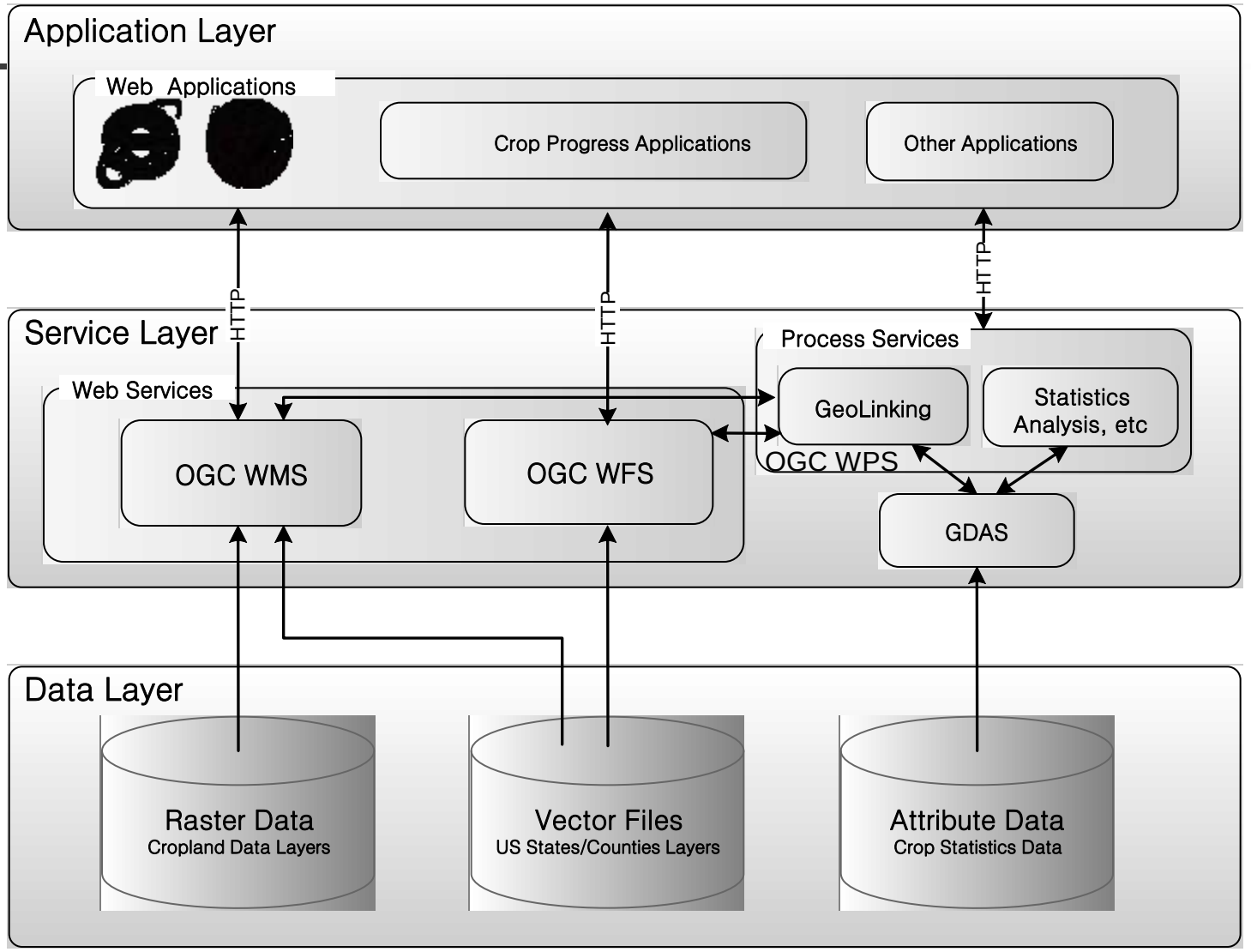
New Vegetation Condition Monitoring System - VegScape

- Different sensor - MODIS
  - Daily repeat => weekly composite
  - 250 meter spatial resolution;
  - Rich cloud pixel information and better preprocessing;
- GIS technology provides
  - Web-based interactive mapping
  - Various online capabilities: online navigation, zooming, panning, downloading, or on-the –fly processing, online statistics, data profiling, etc.
- VegScape provides
  - Data retrieving and processing automation
  - Web publishing and dissemination automation
  - Irregular, ad-hoc data retrieving and processing for emergency assessment or reporting
  - Objective historical data comparison for crop condition assessment
  - Various vegetation condition metrics;
  - Crop land focused, or even crop specific monitoring;
- VegScape reuses the same geo-information technology as CropScape

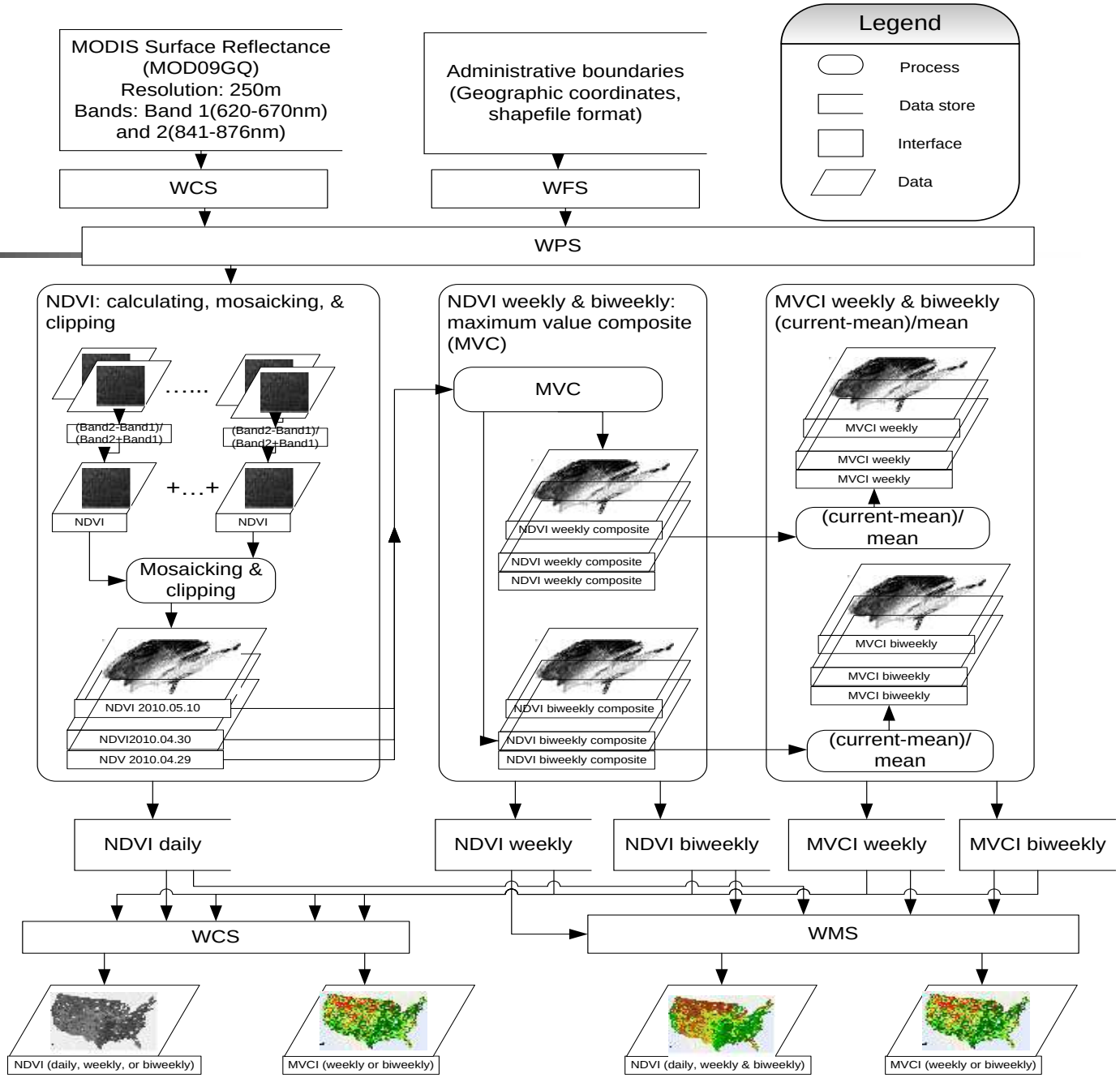
Considerations of Architecture Design and Technology

- Web Based Service Oriented Architecture
- OGC standard compliant web services:
  - Web Feature Service (WFS), Web Map Service (WMS), Web Processing Service (WPS), Sensor Observation Service (SOS), etc.
- Service Integration
  - Support of workflows: Business Process Execution Language (BPEL), BPEL execution engine
  - Re-use all algorithms published in WPS
- Re-use functions/algorithms already developed

Service-Oriented Architecture (SOA)



Data processing



Data processing flow for vegetation index calculation.

Vegtation Condition Indices

$$NDVI = (IR\text{-}R)/(IR+R)$$

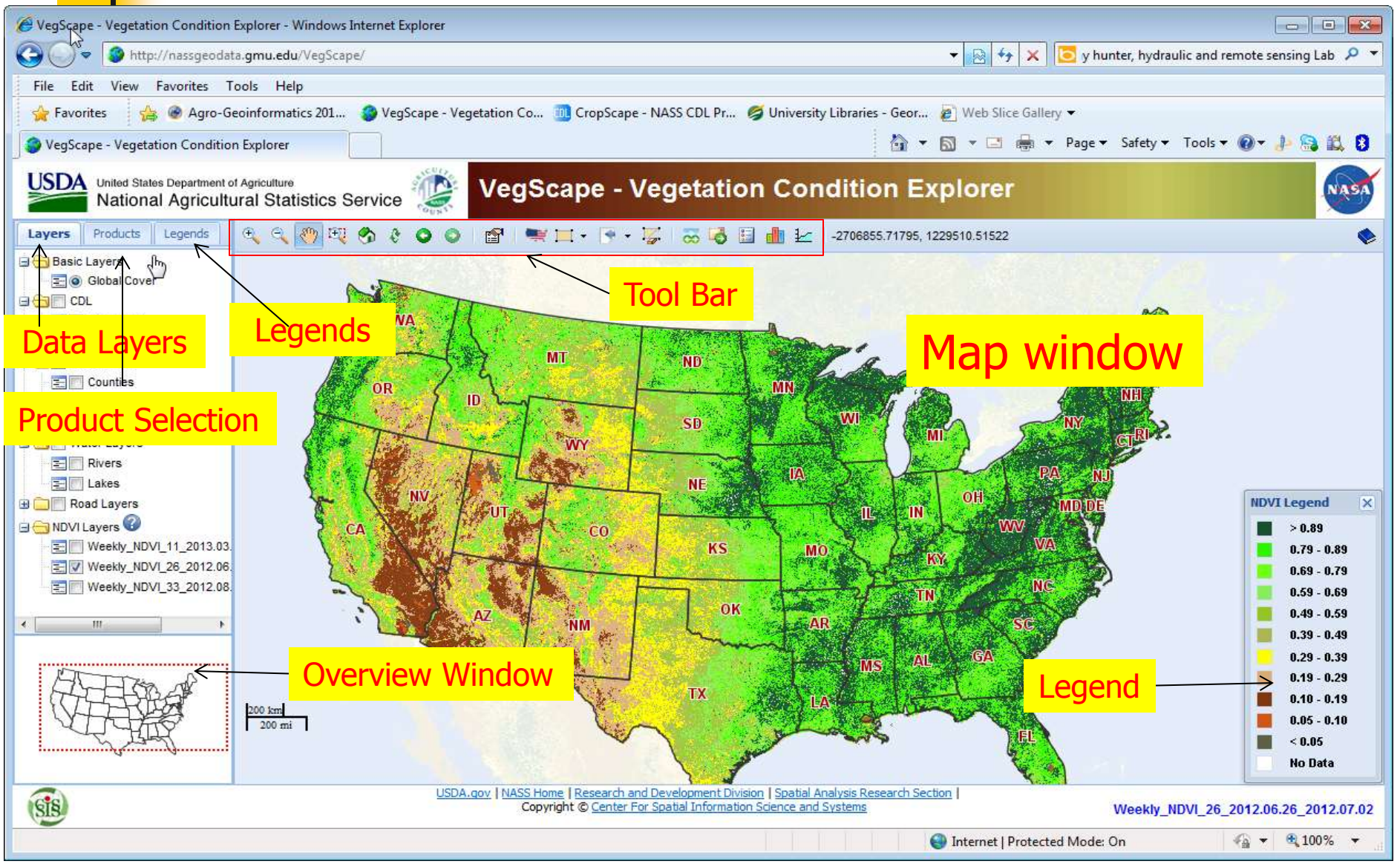
$$MVCI = \frac{NDVI(x,y) - NDVI_m(x,y)}{NDVI_m(x,y)} \times 100$$

$$RMNDVI = \frac{NDVI_i(x,y) - NDVI_{med}(x,y)}{NDVI_{med}(x,y)} \times 100\%$$

$$RPNDVI = \frac{NDVI_i(x,y) - NDVI_{i-1}(x,y)}{NDVI_{i-1}(x,y)} \times 100\%$$

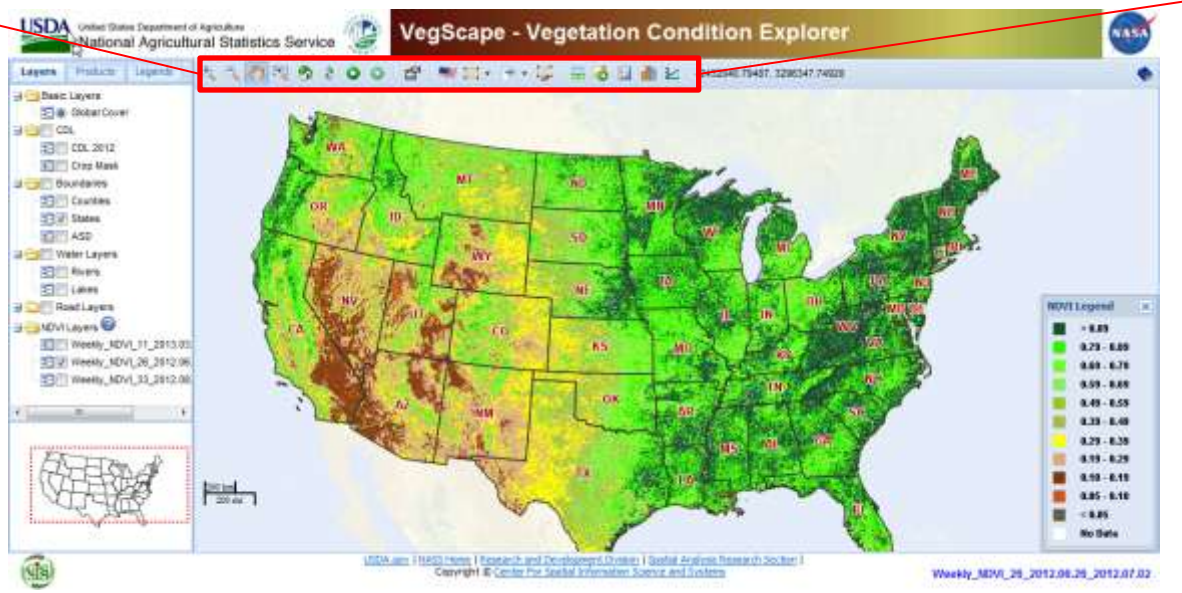
$$VCI = \frac{NDVI(x,y) - NDVI_{min}(x,y)}{NDVI_{max}(x,y) - NDVI_{min}(x,y)} \times 100\%$$

VegScape – Browser Client

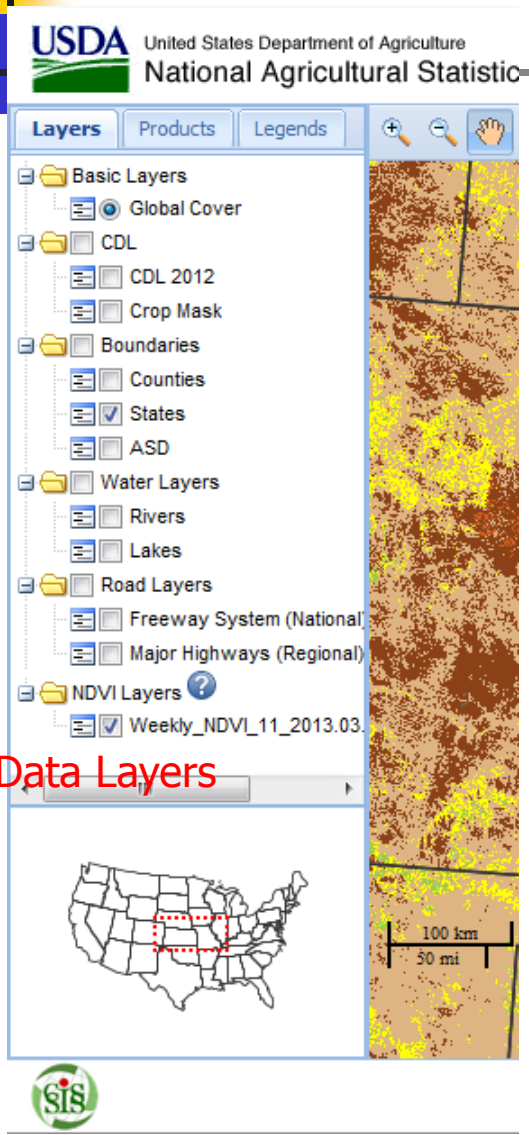


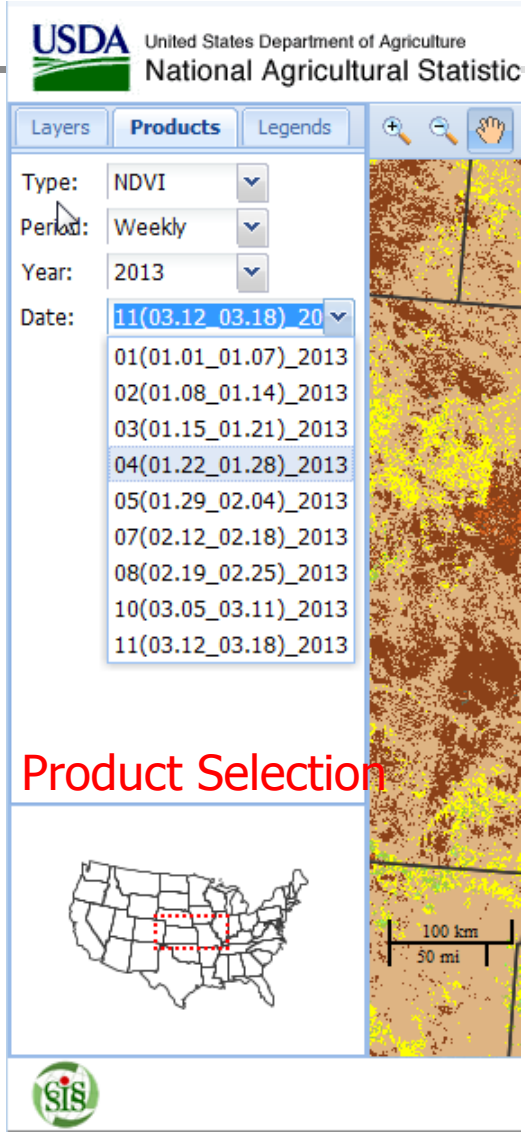
VegScape – Tool Bar

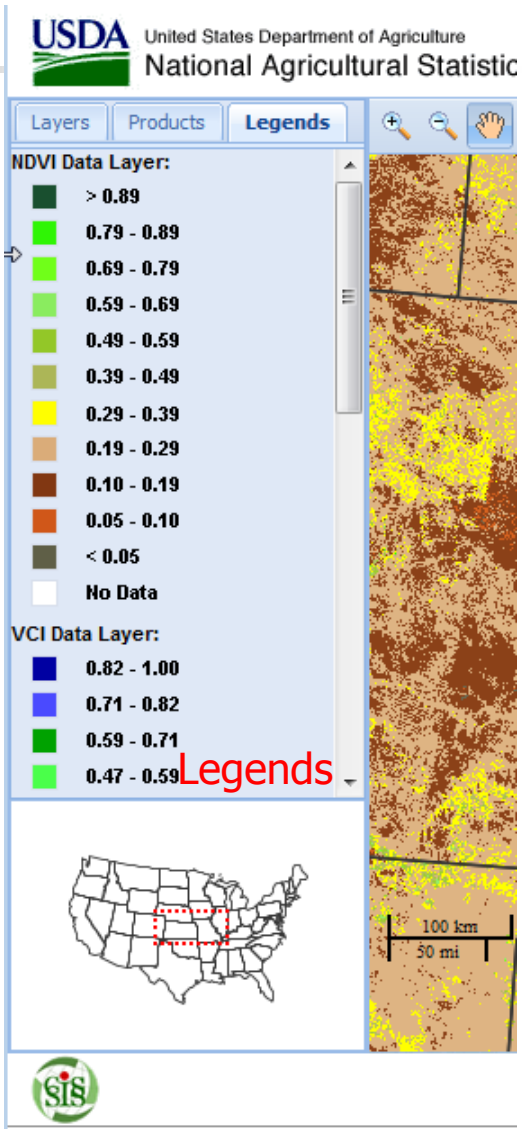
Zoom in
Zoom out
Pan
Drag zoom
Home
Refresh
Previous View
Next view
Identify pixel value
Define state/county AOI
Define rectangle AOI
Import AOI
Swipe layer
Download AOI
Clear AOI
Show/hide legend
Statistics
Profile

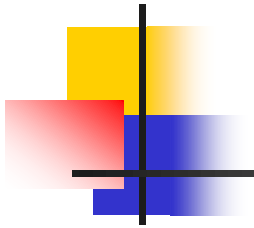


VegScape – Layers, Products and Legends



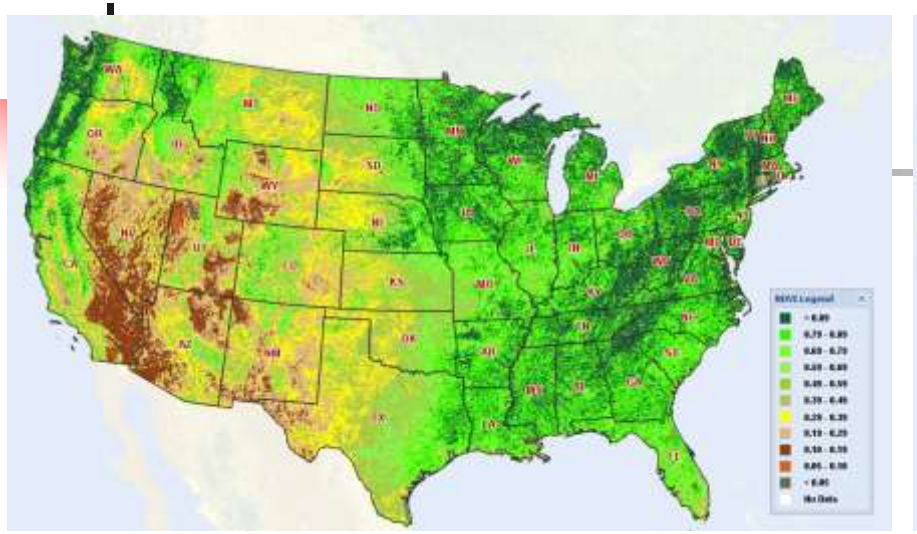




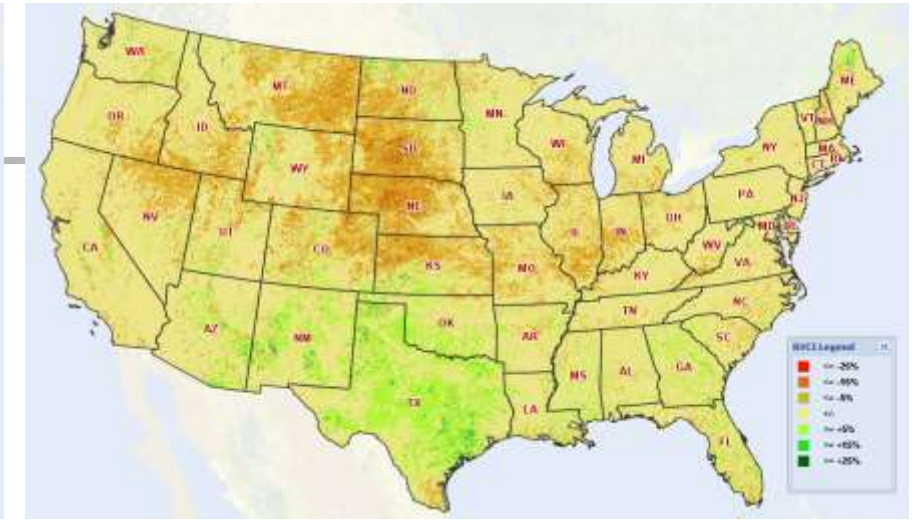


VegScape Function Highlight

Weekly Vegetation Indices 07/24/12 – 07/30/12



NDVI



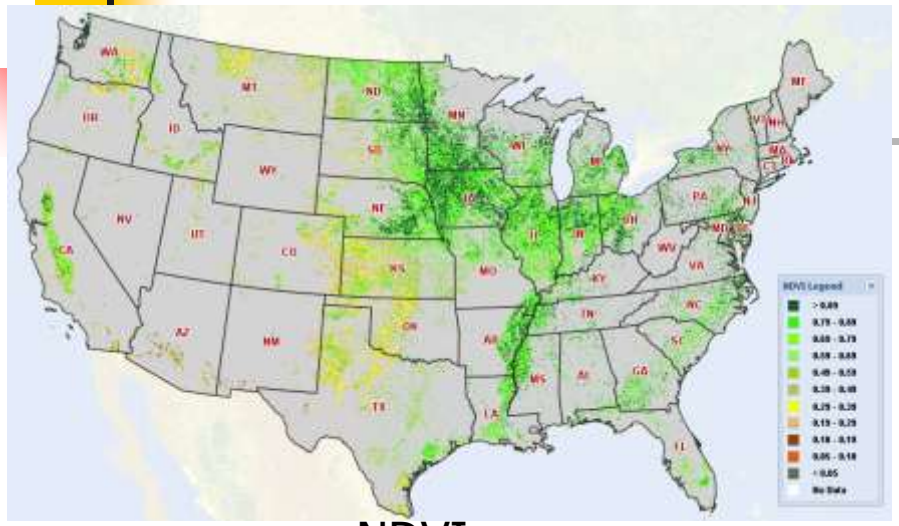
NDVI Ratio to Previous Year

NDVI Ratio to Median

NDVI Ratio to mean

Weekly Vegetation Indices 07/24/12 – 07/30/12

Crop Mask Applied



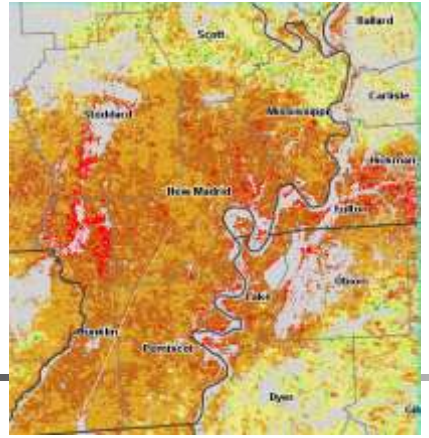
NDVI

NDVI Ratio to Previous Year

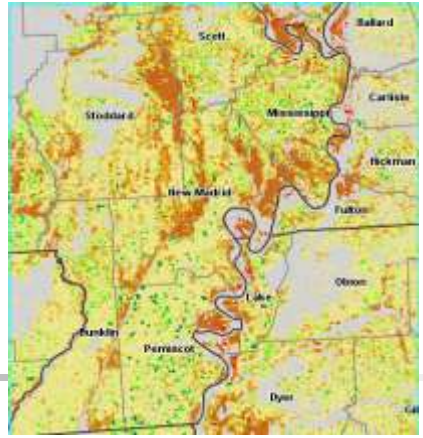
Ratio Median NDVI or RMVCI

Mean NDVI or MVCI

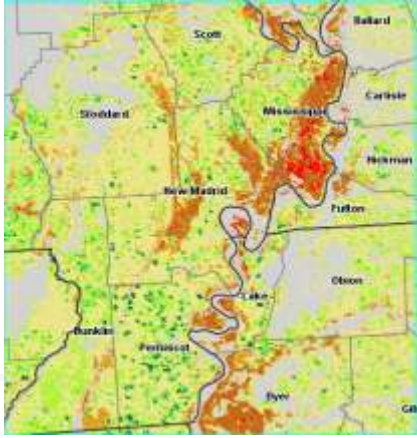
04/12-04/18/11



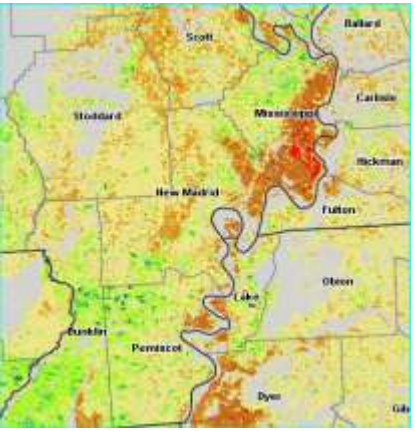
04/19-04/25/11



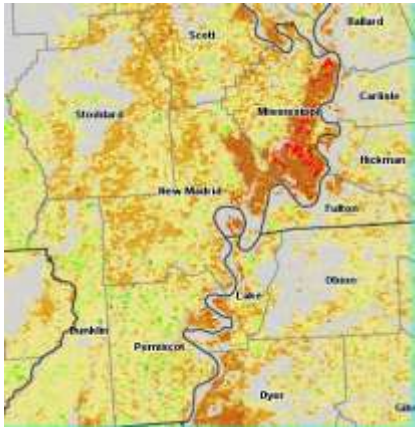
04/26-05/02/11



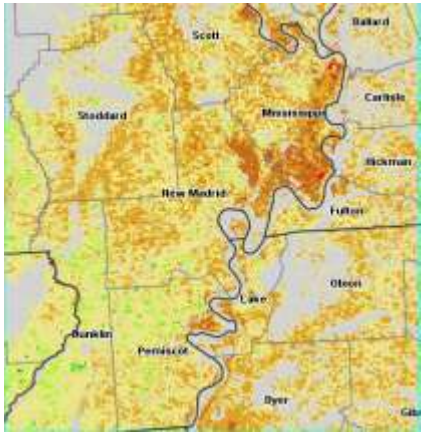
05/03-05/09/11



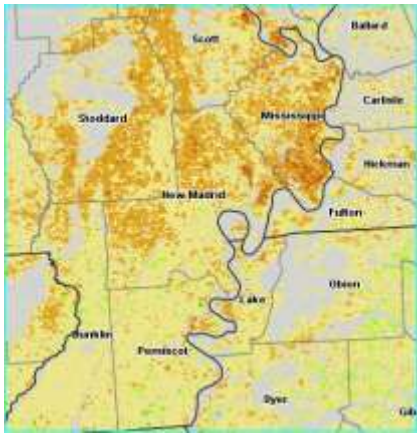
05/10-05/16/11



05/17-05/23/11

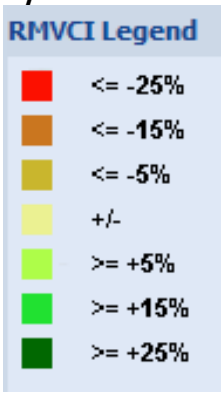


05/24-05/30/11



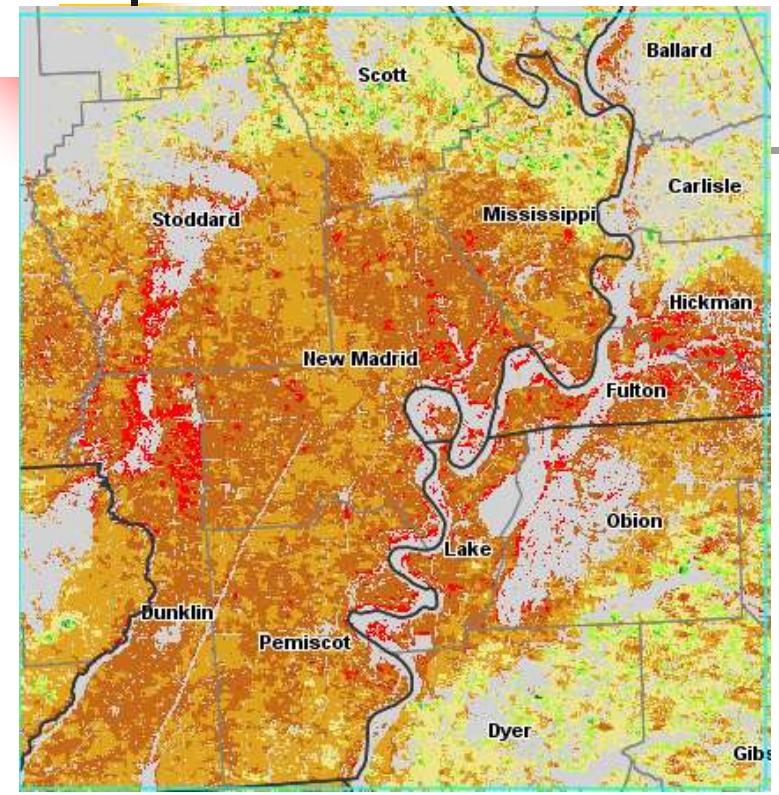
05/31-06/06/11

Cropland Data Layer



2011 Flood Missouri Bootheel NDVI Ratio to Median (Median of 10 years NDVI)

AOI Statistics - Ratio to Median VCI

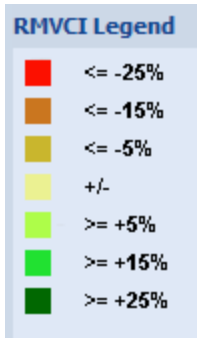


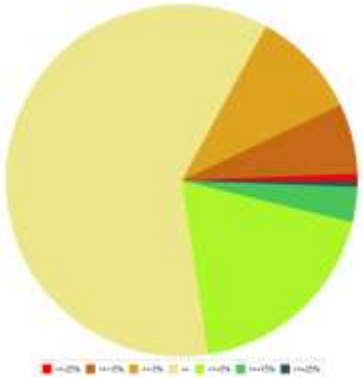
Weekly_RMNDVI_18_2011.05.03_2011.05.09 Data Layer Statistics for the Defined Area of Interest

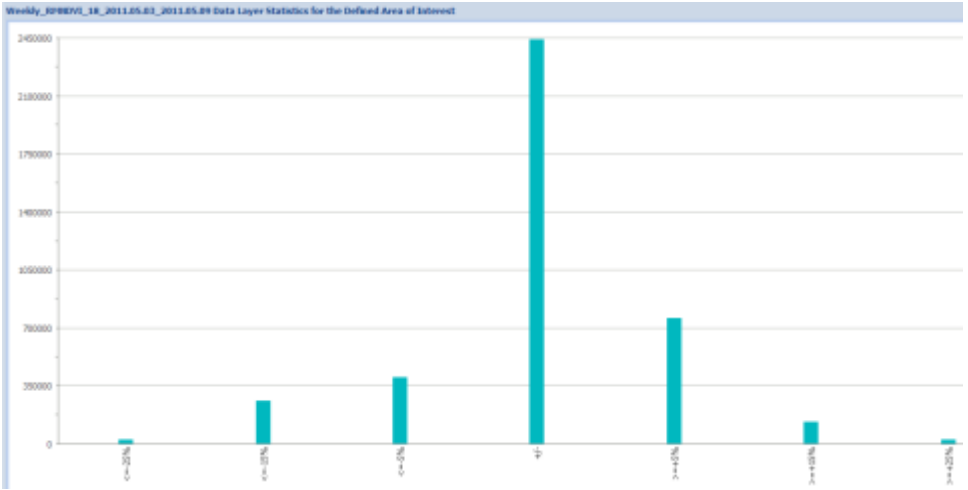
Note: Pixel and acreage counts are not official estimates.

Value	Category	Pixel Counts	Acreage
0	<=-25%	1931	25606.6
1	<=-15%	19647	260535.3
2	<=-5%	30411	403274.7
3	+/-	184180	2442377.2
4	>=+5%	57280	759579.6
5	>=+15%	9910	131414.7
6	>=+25%	1765	23405.3
Total	**7**	**305124**	**4046193.4**

04/19-04/25/11
Quantify vegetative area condition

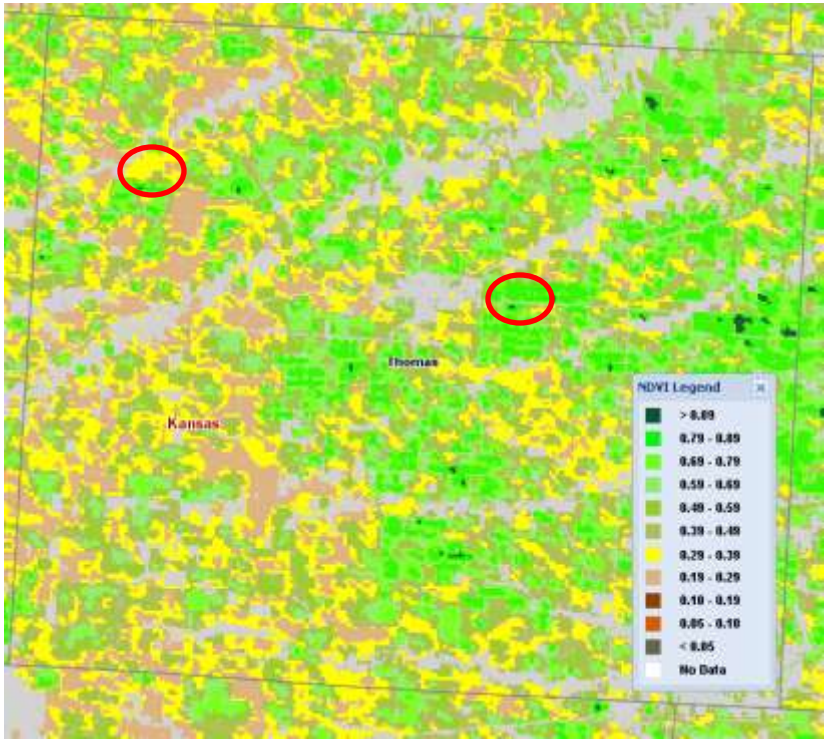






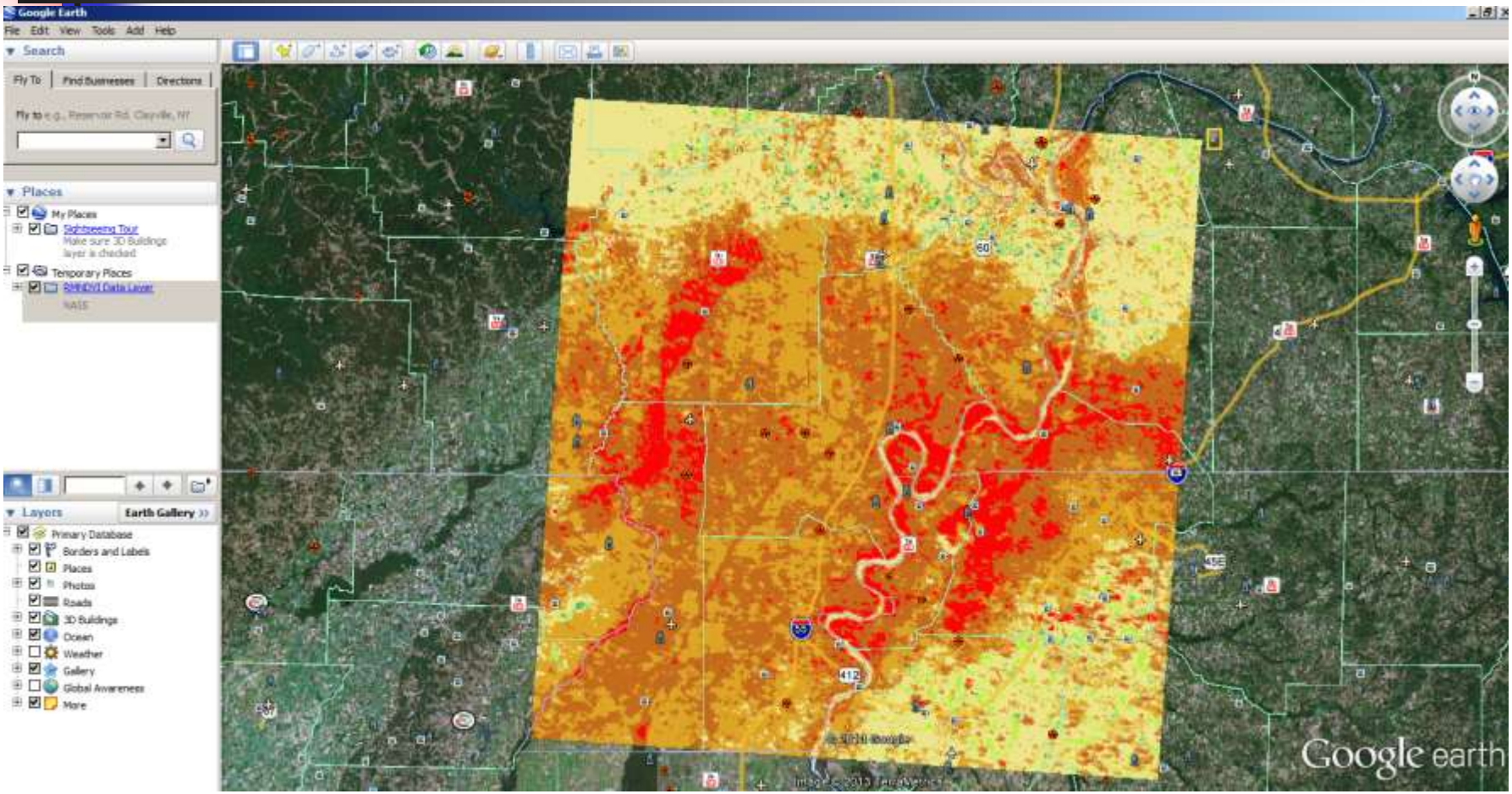
VegScape Serves 2012 CDL by Using CropScape Web Service

2012 Cropland Data Layer
The 2012 Cropland Data Layer (CDL) product depicts land cover



7/24/12 – 7/30/12 NDVI
Vegetative condition indicates crops under stress from the 2012 drought

Data Mashup with Google Earth



Export any selected index data directly into **Google Earth**

Conclusions

- MODIS offers high spatial/temporal resolution & data continuity
- Web-based dynamic interactive mapping
  - Dynamic maps of Multi vegetation condition indices
  - Online navigation, zooming, panning, downloading, on-the-fly processing
  - Online analytics: Statistical analysis and change comparison
  - Automatic data retrieval, processing, publishing, and dissemination
- Irregular, ad-hoc data retrieval and processing for emergency assessment/reporting
- Assessing crop condition and identifying the areal extent of floods, drought, major weather anomalies, and vulnerabilities of early/late season crops
- Consider VegScape operational upon start of 2013 growing season!
- Unfinished business:
  - Further refine data processing algorithms to improve performance and quality;
  - Finish implementing and deploring web services.
  - Further enhancing and adding more functionalities

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AGRICULTURE COUNTS NASS

Questions & Comments?

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