



Vegetation Condition Indices for Crop Vegetation Condition Monitoring

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Outline

- National Crop Condition Monitoring System Background
- Project goals
- Prototypes & data processing
- Vegetation Condition Indices
- Summary



National Crop Condition Monitoring System (NCCMS) Background

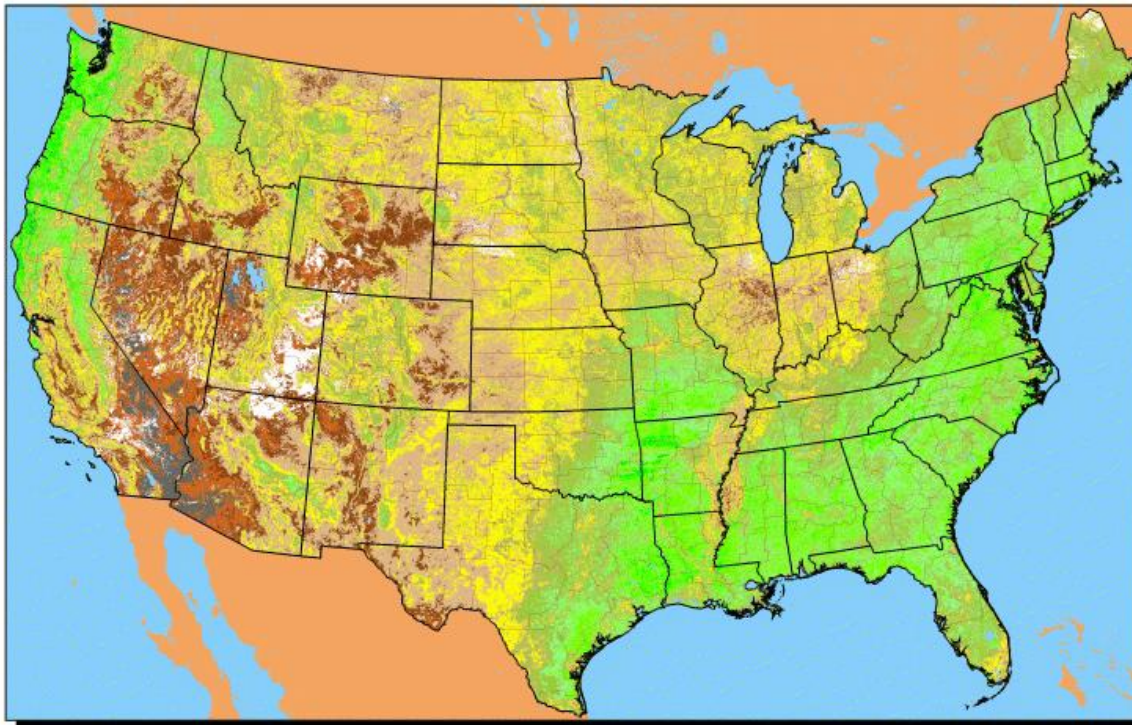
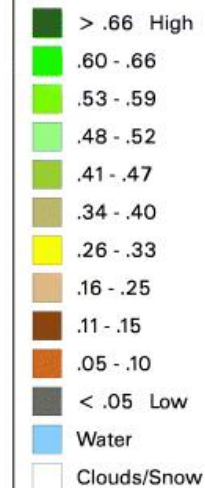
- NASS currently
 - Conducts ad-hoc point survey for crop condition and soil moisture
 - Publishes weekly report based on survey
- Uses AVHRR for RS vegetation condition monitoring
 - AVHRR 17 – Dead least year;
 - AVHRR 18 – Aging, and not consistent with AVHRR 17.
 - Low spatial resolution (1km)
 - Low temporal resolution (biweekly)
 - Static NDVI map
 - Percent change ratio to previous year NDVI
 - Percent change ratio to historical Median

Current Static Crop Condition Image (NDVI)

Conterminous U.S. Vegetation Condition - 2010
Period 43 (10/12 - 10/25)

No Water Vapor
Correction Applied

Vegetation Index



Agricultural Statistics Districts

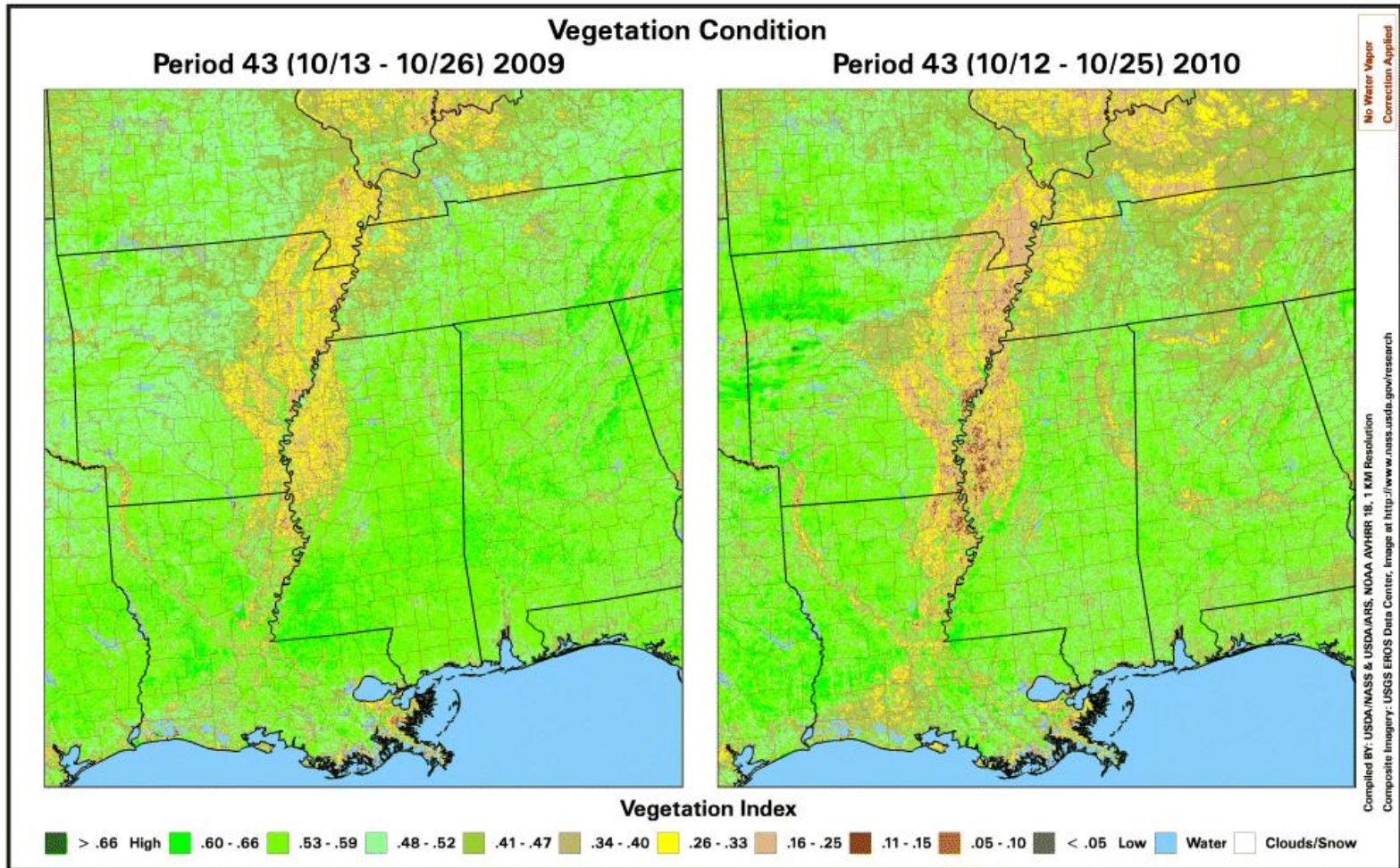
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Original Imagery: NOAA-18 AVHRR
Resolution: 1 Kilometer
Composite Imagery: USGS EROS Data Center
Questions email: hq_rdd_gib@nass.usda.gov

For Additional Images Please See:
www.nass.usda.gov/research

0 100 200 300 400 500 Miles

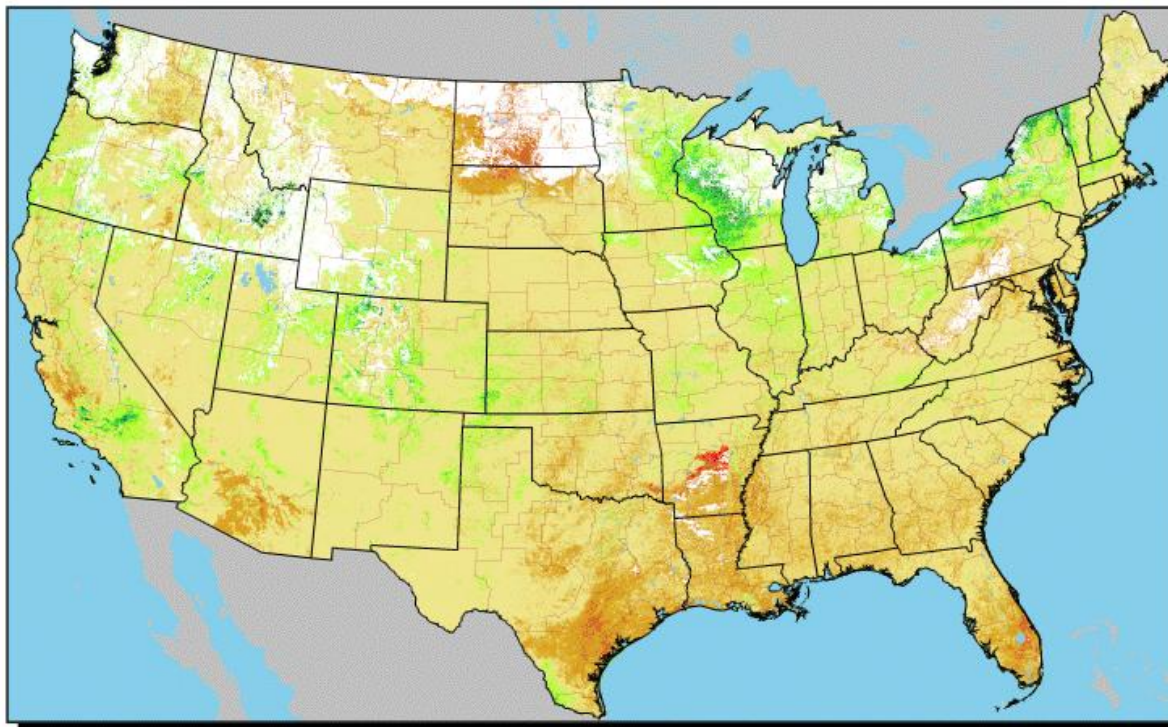
Yearly Comparison to Previous Year



NDVI Ratio Comparison to Previous Year in Percent

Vegetation Condition Percent Change: 2009 ÷ 2008
Period 12 (3/10 - 3/23)

No Water Vapor
Correction Applied



Percent Change

- < = -25%
- < = -15%
- < = -5%
- +/-
- > = +5%
- > = +15%
- > = +25%
- Clouds/Snow

Agricultural Statistics Districts

1:15,000,000

Original Imagery: NOAA-17 AVHRR
Resolution: 1 Kilometer
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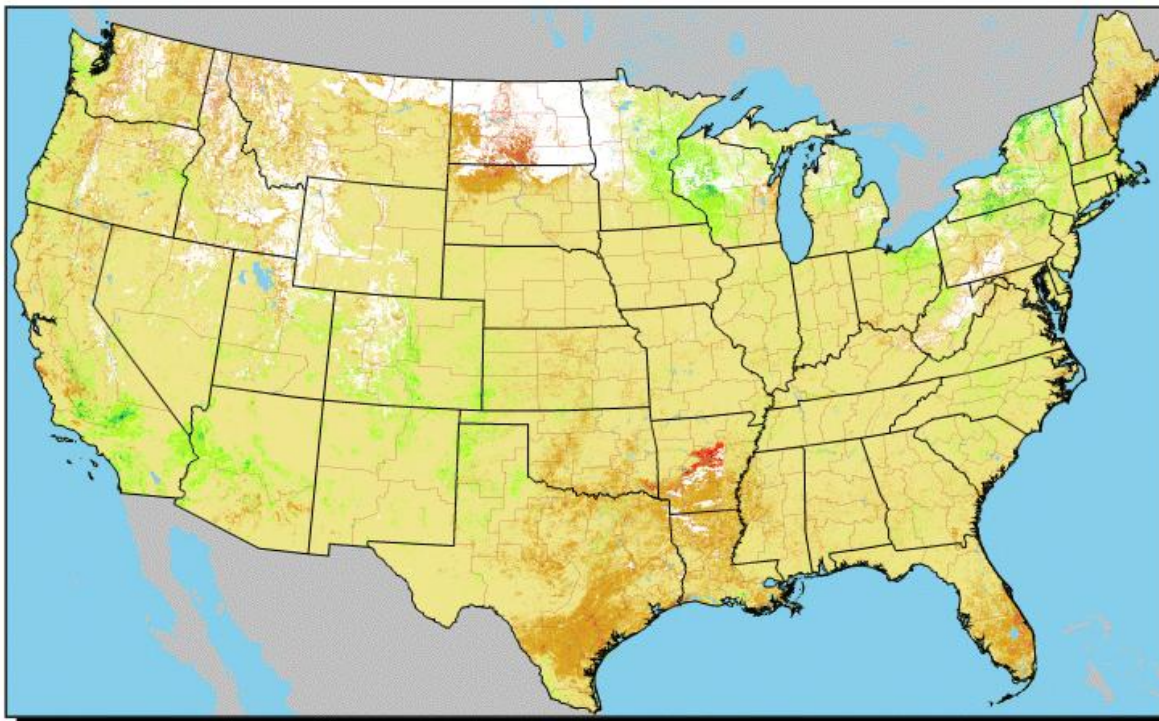
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To Download Raw Images:
<http://www.nass.usda.gov/research/avhrr/scenes.html>

0 100 200 300 400 500 Miles

NDVI Percent Change W.R.T. to Median

Vegetation Condition Percent Change: 2009 ÷ Median (2004 → 2008)
Period 12 (3/10 - 3/23)

No Water Vapor
Correction Applied



Percent Change

- < = -25% *
- < = -15%
- < = -5%
- +/-
- > = +5%
- > = +15%
- > = +25%
- Clouds/Snow

* Variations in Snow Cover May Unduly Influence this Category

Agricultural Statistics Districts

1:15,000,000

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0 100 200 300 400 500 Miles



Why A New Vegetation Condition System?

- We need:
 - better spatial and temporal resolutions;
 - data processing and web publishing automation;
 - better visualization and data dissemination;
 - vegetation condition metric improvement and quantitative calibration with ground truth;
 - Integrating soil moisture, temperature, etc. information.



Project Goals

- Improve the objectivity, robustness and defensibility of nationwide crop condition monitoring operation at NASS
- Prototype an operational National Crop Condition Monitoring System (NCPMS) to enhance data accessibility, interoperability and dissemination.
- Produce crop condition data products that are complementary to existing NASS crop condition survey products.



New Vegetation Condition Monitoring System

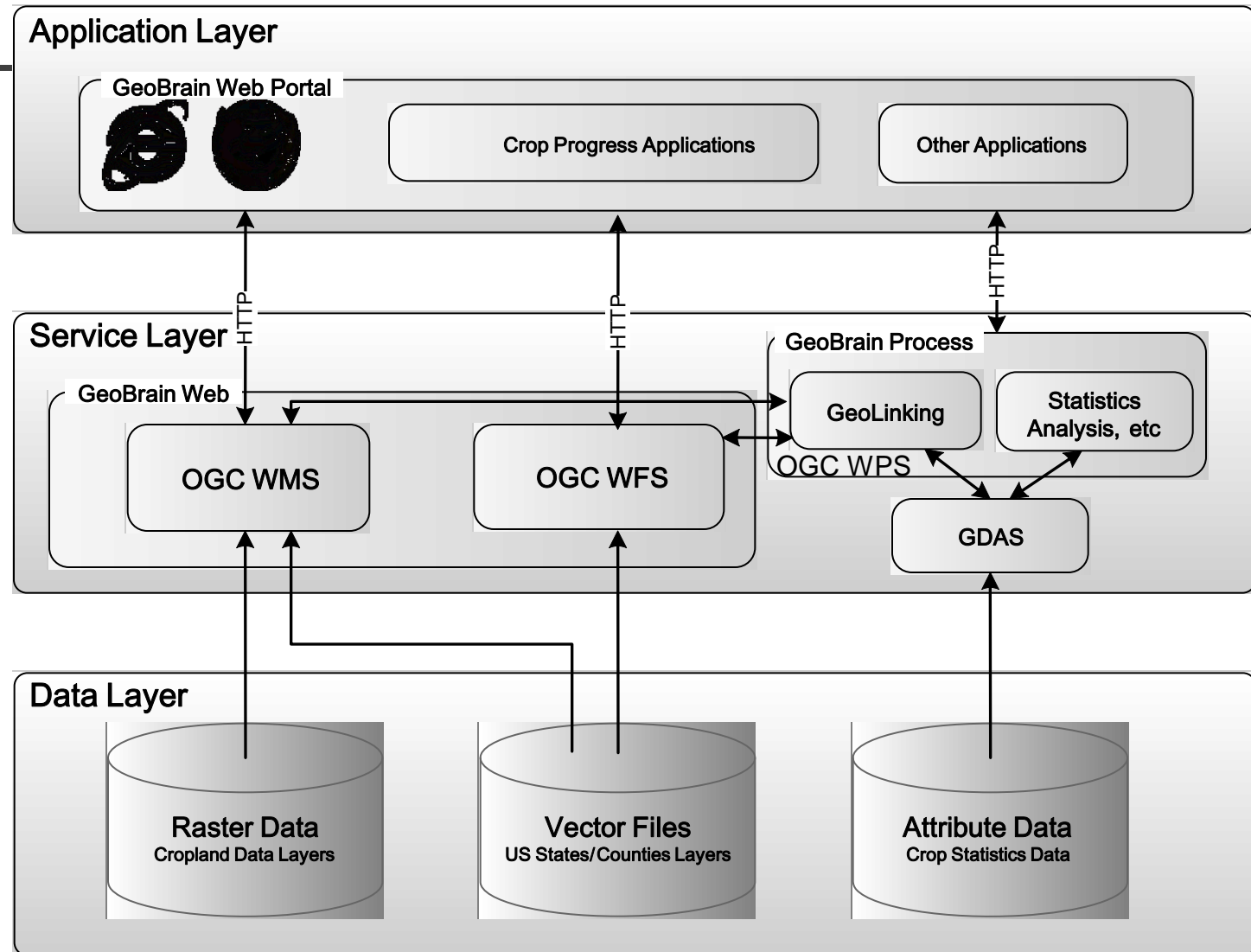
- New system will provide
 - Data retrieving and processing automation
 - Web publishing and dissemination automation
 - Irregular, ad-hoc data retrieving and processing for emergency assessment or reporting
 - Objective quantification & historical data comparison for crop condition assessment
 - **Using various vegetation condition metrics;**
 - Crop land focused, or even crop specific monitoring;



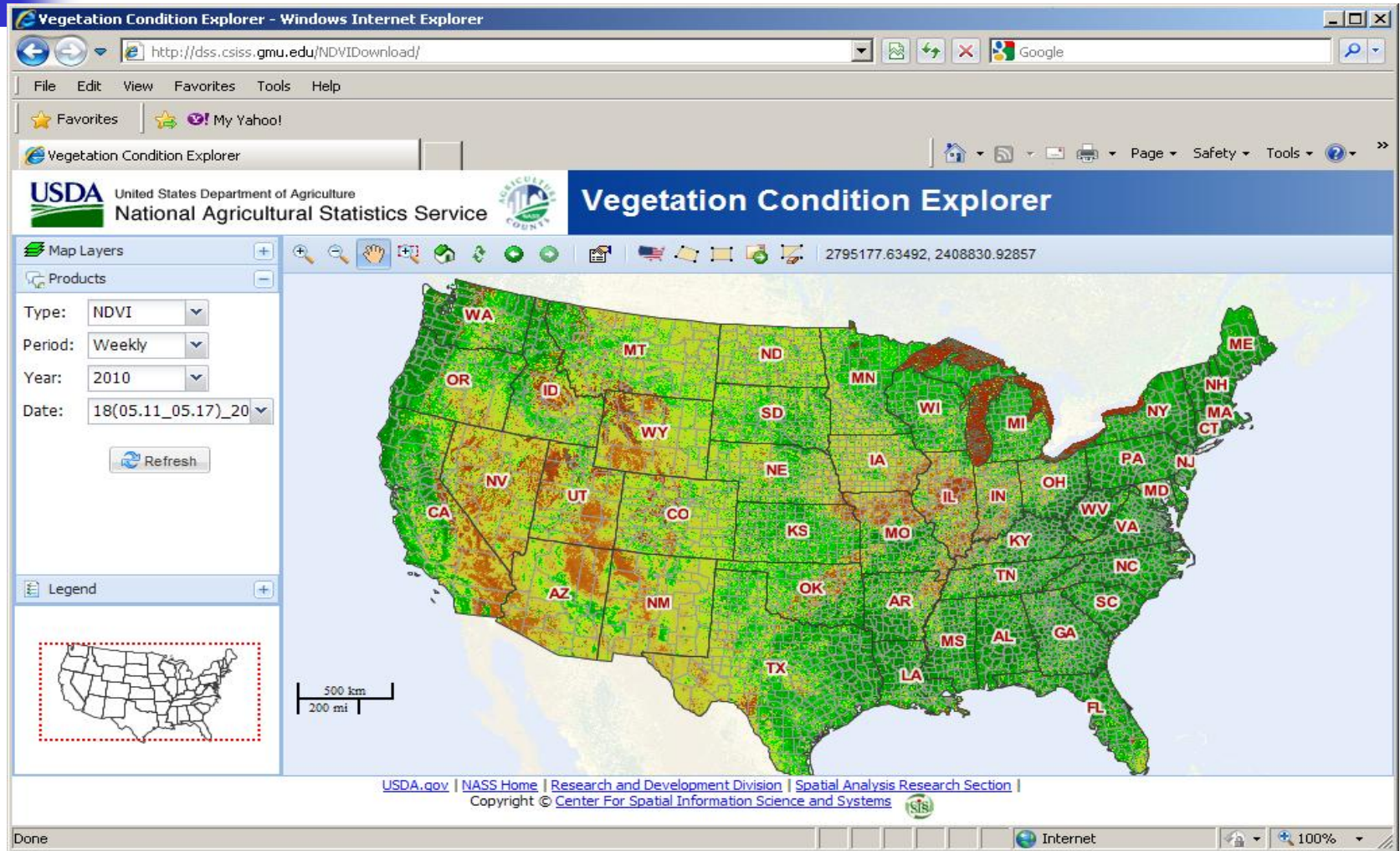
New Vegetation Condition Monitoring System (Cont.)

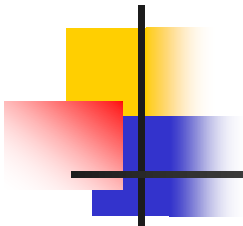
- Using different sensor - MODIS
 - Daily repeat => weekly composite
 - 250 meter spatial resolution;
 - Rich cloud pixel information and better preprocessing;
- GIS technology provides
 - Web-based interactive mapping
 - Various online capabilities: online navigation, zooming, panning, downloading, or on-the-fly processing, etc.

System Architecture: Web Service-Oriented Architecture (SOA)



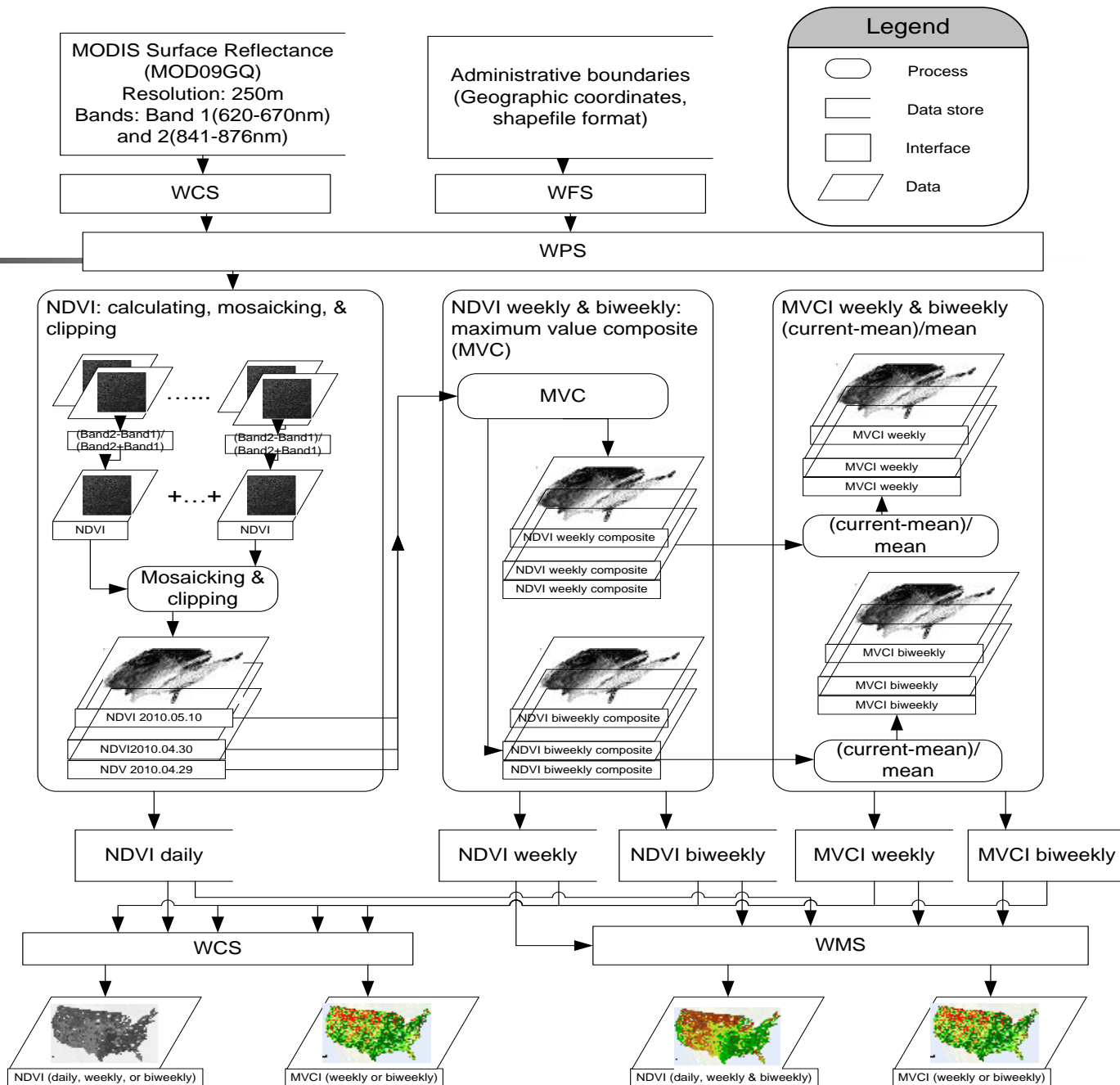
Vegetation Condition Explorer Prototype





Data processing

Data processing flow for vegetation index calculation.



Mean Referenced Vegetation Condition Index - MVCI

- Let $NDVI_m(x, y)$, $NDVI_{max}(x, y)$ and $NDVI_{min}(x, y)$ be the mean, maximum and minimum of the time series NDVI at location (x, y) across entire time span. Let $NDVI_i(x, y)$ be the current NDVI. Then a measure of vegetation condition can be defined by the NDVI percent change ratio to the historical NDVI time series mean $NDVI_m(x, y)$ as following:

$$MVCI = \frac{NDVI_{i, x, y} - NDVI_{m, x, y}}{NDVI_{m, x, y}} \times 100$$



NDVI Change Ratio to Previous Year

- Let $NDVI_i(x, y)$ be the current year NDVI value at location (x, y) , and $NDVI_{i-1}(x, y)$ be the previous year NDVI. The current year NDVI ratio to the previous year value is given by

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



NDVI Change Ratio to Median

- Let $NDVI_{med}(x, y)$ be the median of an N year NDVI time series at location (x, y) and $NDVI_i(x, y)$ be the i th year NDVI. The i th (current) year NDVI change ratio to the median NDVI value of the N year time series is given by:

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

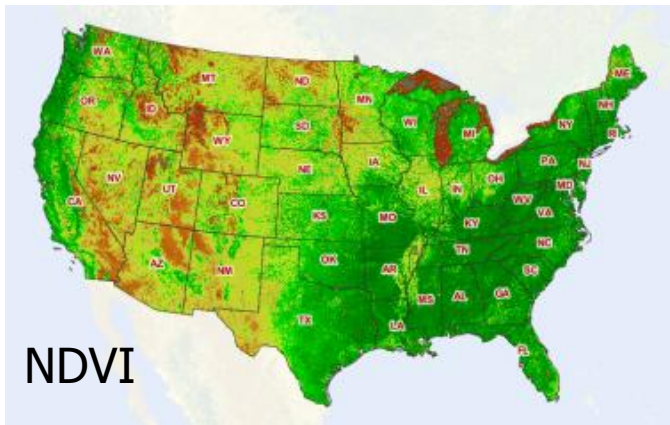
Vegetation Condition Index - VCI

- Kogan [5] proposed a vegetation condition index based on the relative NDVI change with respect to minimum historical NDVI value. It was defined as following:

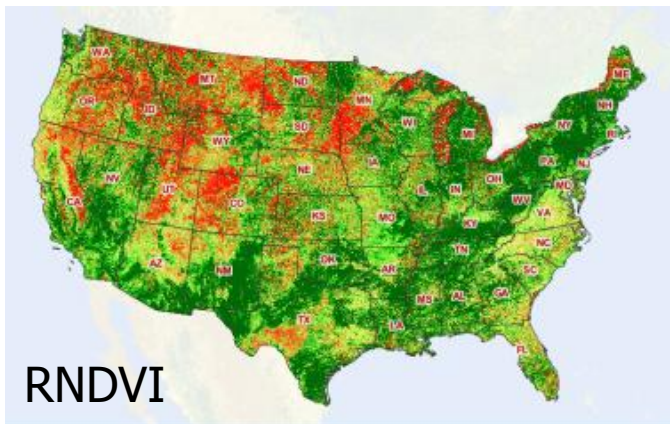
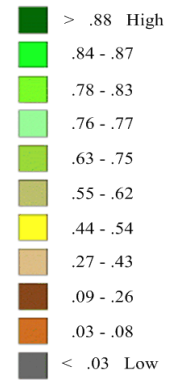
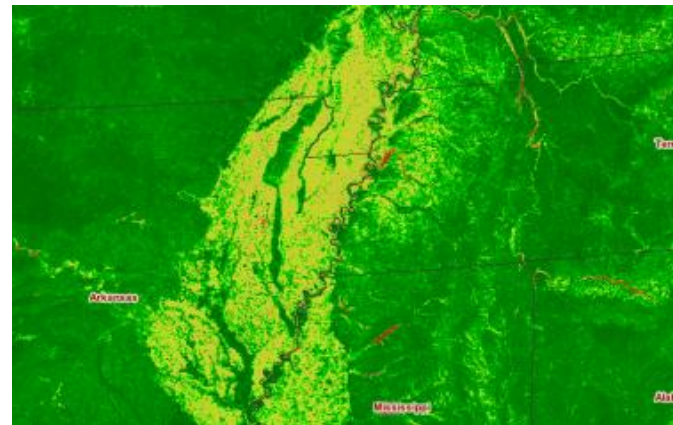
$$VCI = \frac{NDVI_{x,y} - NDVI_{min\ x,y}}{NDVI_{max\ x,y} - NDVI_{min\ x,y}} \times 100\%$$

- This normalized index indicates percent change of the difference between the current NDVI index and historical NDVI time series minimum with respect to the NDVI dynamic range.

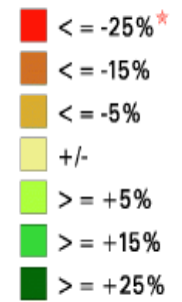
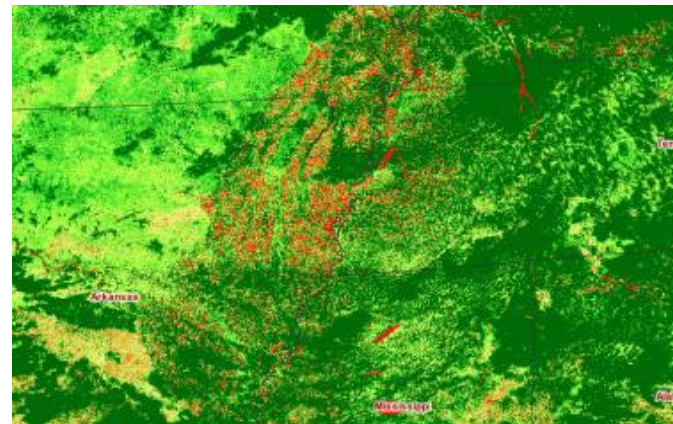
NDVI and RNDVI



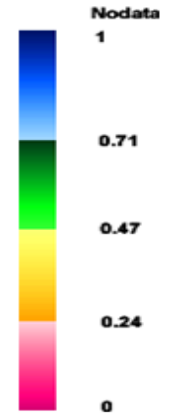
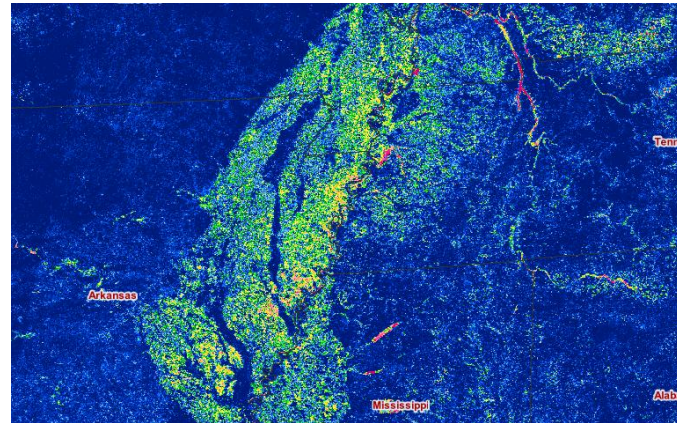
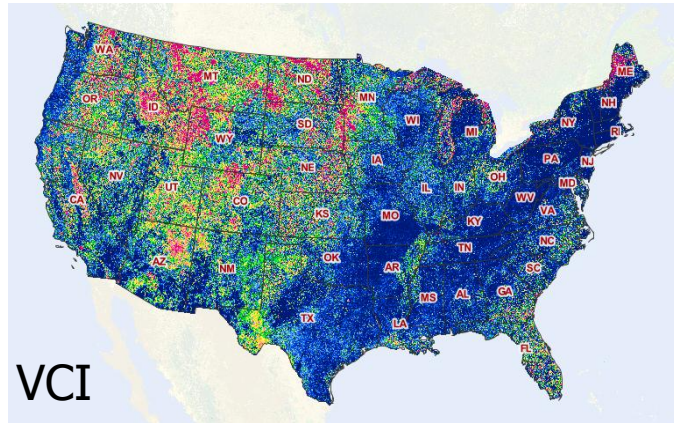
NDVI



RNDVI



VCI Result





Summary I

- MVCI is more computationally efficient than NDVI ratio to the historical median (RMNDVI).
- RNDVI has big variance as expected.
- In general, the patterns of MVCI, RNDVI, RMNDVI and VCI are similar. Locally, there are huge difference between RNDVI, MVCI, RMNDVI, and VCI.
- MVCI and VCI provide more additional metrics for real world vegetation condition monitoring.
- It is difficult to tell which index is the best for vegetation condition monitoring



Summary II

- Current status
 - More vegetation condition metric used;
 - Demo system is being prototyped;
- Challenges:
 - Integrating with other info.
 - Soil moisture (Surface, Root-zone (6-in))
 - Temperature (Max, min)
 - Calibration with ground truth
 - Quantifying crop condition
 - Ground truth data collection

A decorative graphic consisting of overlapping yellow, red, and blue squares with a black crosshair.

Questions & Comments?

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NASS

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UNITED STATES DEPARTMENT OF AGRICULTURE