

Remote Sensing for Monitoring USA Crop Production: What is the State of the Technology

Monitoring Food Security Threats from Space - A CELC Seminar

Centurion, SA

21 April 2016



David M. Johnson
Geographer

United States Department of Agriculture
National Agricultural Statistics Service



National Agricultural Statistics Service (NASS)

Provider of timely, accurate, and useful statistics in service to U.S. agriculture



NEWS RELEASE

NATIONAL AGRICULTURAL STATISTICS SERVICE
 United States Department of Agriculture • Washington, DC 20250
 Ag Statistics Hotline: (800) 727-6540 • www.nass.usda.gov

Contact: Ellen Dougherty, (202)

http://www.nass.usda.gov:8080 - 2002 Census of Agriculture - SVG Interactive Mapping - United S - Microsoft Internet Ex...

National Agricultural Statistics Service 2002 Census of Agriculture

United States | All data items are from Chapter 2 - Table 1: Area Summary Highlights: 2002
 Selected crops harvested - Land in orchards (acres)

State: [United States - County Level] Data Item: [Selected crops harvested - Land in orchards (acres)]

Data

United States Total: 5,330,439

State Total:

County:

County Total:

Download data as CSV | XML | PDF

Help | Print | Return to Query

NASS - Data and Statistics - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address: http://www.nass.usda.gov/Data_and_Statistics/Index.asp

United States Department of Agriculture
 National Agricultural Statistics Service

The 2002 Census of Agriculture is the most comprehensive source of statistics portraying...

Search

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Data and Statistics

Quick Stats (Agricultural Statistics Data Base)

NASS publishes U.S., state, and county level agricultural statistics for many commodities and data series. Quick Stats offers the ability to query by commodity, state(s) and year(s), providing the most up-to-date statistics including all revisions. The query dataset can be downloaded for easy use in your database or spreadsheet.

Query our Quick Stats Data Base

Additional Crops County Resources

Maps of crops county estimates for acreage and yield are available from NASS as both CSV data files and maps. County data from Quick Stats data is also available in pre-treated data sets by year and by crop.

Census of Agriculture

USDA United States Department of Agriculture
 National Agricultural Statistics Service

Quick Stats

Navigation History: Keyword Search Hints Search

Status: 31,207,531 records.
 Select one or more items to filter records. There are currently 31,207,531 records available.

Select Commodity (one or more)

Program: CENSUS SURVEY

Sector: ANIMALS & PRODUCTS, CROPS, DEMOGRAPHICS, ECONOMICS, ENVIRONMENTAL

Group: ANIMAL TOTALS, AQUACULTURE, CROP TOTALS, DAIRY, ENERGY EXPENSES, FARMS & LAND & ASSETS, FIELD CROPS, FRUIT & TREE NUTS

Commodity: AG LAND, AG SERVICES, AG SERVICES & RENT, ALMONDS, ALPACAS, AMARANTH, ANIMAL SECTOR, ANIMAL TOTALS, ANIMALS, OTHER

Select Location (one or more)

Geographic Level: AGRICULTURAL DISTRICT, COUNTY, INTERNATIONAL, NATIONAL, REGION, MULTI-STATE, SUB-STATE

per 2002

ect to use hiring prices, or other

hat the most

ange 7/2002

ercent

30 - 49	4,700	3,440	-27
50 - 99	7,400	5,800	-24
100 - 199	1,900	2,080	+9
200 - 499	700	900	+29
500+	200	440	+120
Total	17,500	19,900	-20

17The May 2007 projection is based on farmers' opinions May-June 2002, with the assumption that milk prices for the next five years will be at the same level as the past five years.

USDA CENSUS OF AGRICULTURE
 United States Department of Agriculture

About the Census | Newsroom | Publications | Your Census, Your Story.

Popular Topics

- 2012 Census Results
- Frequently Asked Questions
- Infographics
- State and County Data
- Desktop Query Tool
- Historical Census Data
- Partner Tools

U.S. WHO, WHY, HOW

STATE

Headlines

- STATEMENT: Statement from Agriculture Secretary Tom Vilsack on Updated 2012 Census of Agriculture Data
- 2012 Census of Agriculture Reveals New Trends in Farming
- MEDIA ADVISORY: USDA to Release Final 2012 Census of Agriculture Results on May 2
- New Agriculture Census Data Coming May 2
- BLOG: A Census Story from Benton County, Mississippi
- SECRETARY'S COLUMN: Census of Agriculture Results Tell Story of Unleashed Potential in Rural America

Data Search Tools

- Quick Stats
- Quick Stats Tutorial
- Desktop Data Query Tool
- Ag Atlas Maps

GET THE AG CENSUS

Recent Census

2012 Census of Agriculture

USDA National Agricultural Statistics Service

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Updated design. Enhanced search. Mobile optimization. Have a look around. We hope you like it.

Find Data and Reports by:

Select a State

Find a Regional or State Field Office

Today's Reports

Sep 29, 2015

- Agricultural Prices Released at 3:00 pm ET Report pending.
- Peanut Stocks and Processing Released at 3:00 pm ET Report pending.

Headlines

- 09/25/15 U.S. Hogs and Pigs Inventory Up 4 Percent
- 09/22/15 USDA NASS Begins Gathering Food Safety Data About Fruit and Vegetable Operations Nationwide
- 08/17/15 Sales from U.S. Organic Farms Up 72 Percent, USDA Reports
- 08/31/15 Most of the U.S. Rented Farmland is Owned by Non-Farmers
- 08/19/15 USDA Report Shows Increasing Internet Access on U.S. Farms

Twitter

USDA-NASS @usda_nass
 Arizona's cotton harvest is complete on 15% of acreage, slightly ahead of 5-year average. #agchat pic.twitter.com/7ZCduP5t16 @ Show Photo

UNL CropWatch @UNL_CropWatch
 Nebraska harvest was at 10% Sunday, 5 pts behind average, but ahead of last year. #NEchat @NE_Combat @usda_nass pic.twitter.com/yN1Auz0Z @ Remoted by USDA-NASS

Quick Stats Online Response

6:39 AM 9/29/2015

Daily Farmer Price for May 2007 1/ by Herd Size

herds	Keep same herd size	Increase herd size	Discontinue milking
under			
1-29	47	17	58
30-49	71	9	20
50-99	85	19	18
100-199	53	37	10
200-299	95	59	8
300+	22	78	0
Total	400	200	20

Percent of Herds by Size Group 2007 Projection

1The May 2007 projection is based on farmers' opinions May-June 2002, with the assumption that milk prices for the next five years will be at the same level as the past five years.

NASS Research and Development Division

Geospatial Information Group

NASS - Research and Science - Windows Internet Explorer

http://www.nass.usda.gov/Research_and_Science/index.asp

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NASS - Research and Science

USDA United States Department of Agriculture
National Agricultural Statistics Service

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- Charts and Maps
- Research and Science
- Education and Outreach

Statistics by State

Select a State

You are here: Home / Research and Science

Research and Science

Spatial Data

Vegetation Condition Images

Cropland Data Layer

Image Gallery (2003) available for these states: Arkansas, Illinois, Indiana, Iowa, N. Dakota, Mississippi, Missouri, Nebraska, Wisconsin

Land Use Strata for Selected States

Census of Agriculture

2002 Census Map Gallery

2002 Maps: Gallery | Star Tree | List

Interact with Data (1997)

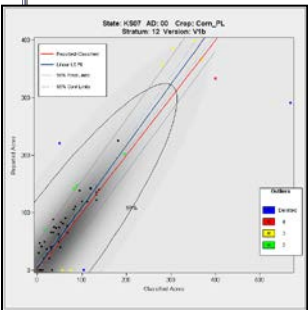
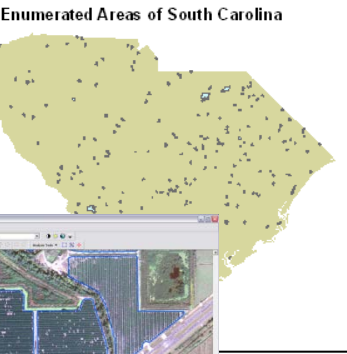
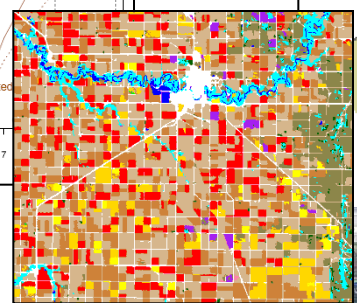
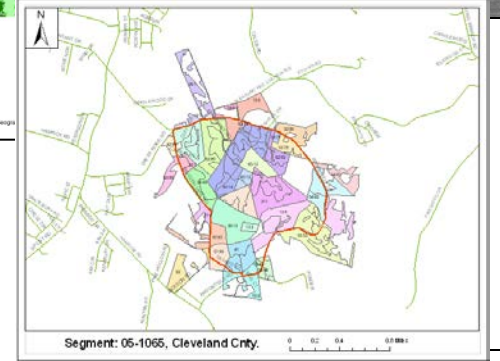
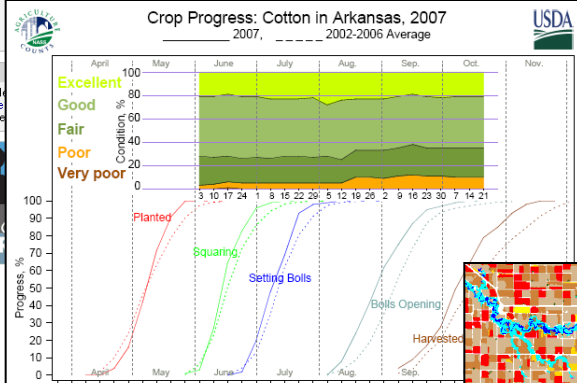
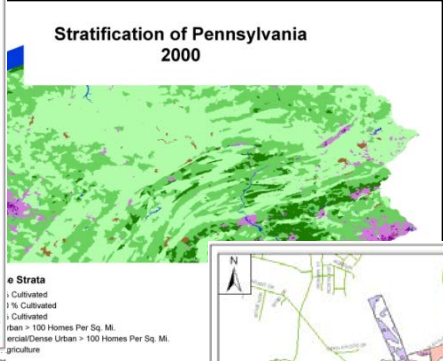
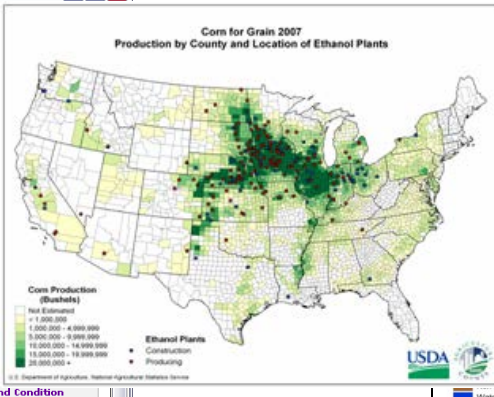
"Linked Micromap" Plots (1997):
Corn | Cotton | Hay | Soybeans | Wheat

Animated Maps

Crop Acreage

Vegetation Condition

Corn | Cotton | Oats
Soybeans | Wheat



ers and Presentations

733 archived reports available

Area: GIS | Survey | Yield

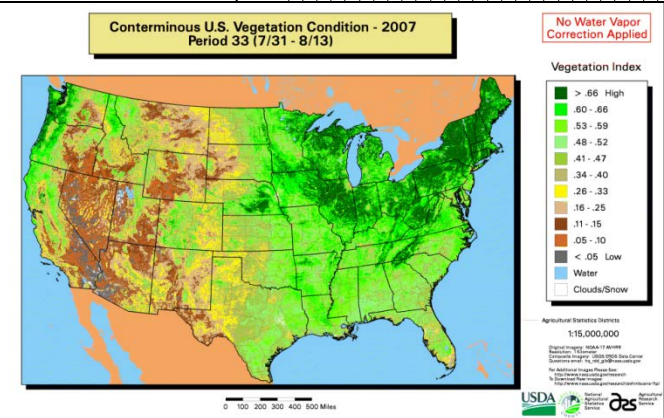
"Star Tree" Diagram

Presenter

Last modified

Statistics System (ESS) | Site Map

Non-Discrimination Statement | IT



Most popular crop reports from NASS



ISSN: 1949-1522

Released June 28, 2013, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

Corn Planted Acreage Up Slightly from 2012
Soybean Acreage Up 1 Percent
All Wheat Acreage Up 1 Percent
All Cotton Acreage Down 17 Percent

Corn planted area for all purposes in 2013 is estimated at 97.4 million acres, up slightly from last year, the highest planted acreage in the United States since 1936 when an estimated 102 million acres were expected to harvest 89.1 million acres for grain, up 2 percent from last year.

Soybean planted area for 2013 is estimated at a record high 77.7 million acres, up 1 percent from last year, at 76.9 million acres, is up 1 percent from 2012 and will be a record high, if realized. Record is estimated in New York, Pennsylvania, and South Dakota.

All wheat planted area for 2013 is estimated at 56.5 million acres, up 1 percent from 2012. The 2012 planted area, at 42.7 million acres, is 3 percent above last year and up 2 percent from the previous about 29.4 million acres are Hard Red Winter, 9.96 million acres are Soft Red Winter, and 3.38 million acres are White Winter. Area planted to other spring wheat for 2013 is estimated at 12.3 million acres, up slightly from about 11.7 million acres are Hard Red Spring wheat. The estimated Durum wheat planted area for 2013 is 1.54 million acres, down 28 percent from the previous year.

All cotton planted area for 2013 is estimated at 10.3 million acres, 17 percent below last year. Up 10.0 million acres, down 17 percent from 2012. American Pima area is estimated at 226,000 acres, 2012.

Acreage



ISSN: 1936-3737

Released May 9, 2014, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

Winter Wheat Production Down 9 Percent from 2013
Orange Production Up Slightly from April Forecast

Winter wheat production is forecast at 1.40 billion bushels, down 9 percent from 2013. As of May 1, yield is forecast at 43.1 bushels per acre, down 4.3 bushels from last year.

Hard Red Winter production, at 746 million bushels, is up slightly from a year ago. Soft Red Winter production, is down 21 percent from 2013. White Winter, at 209 million bushels, is down 7 percent from 2013. White Winter production, 10.9 million bushels are Hard White and 198 million bushels are Soft Red Winter.

The United States all orange forecast for the 2013-2014 season is 7.21 million tons, up slightly from 7.15 million tons in the 2012-2013 final utilization. The Florida all orange forecast (4.96 million tons), is up slightly from the previous forecast but down 17 percent from last season. Early, midseason, and Navel varieties in Florida are forecast at 53.3 million boxes (2.40 million tons), unchanged from the previous forecast but down 14 percent from last season. California and Texas production forecasts are carried forward from April.

Florida frozen concentrated orange juice (FCOJ) yield forecast for the 2013-2014 season is 42.0 degrees Brix, down 1 percent from the April forecast and down 1 percent from last season. The early-midseason portion is projected at 1.53 gallons per box, up 1 percent from 1.51 gallons per box. The Valencia portion is projected at 1.64 gallons per box, down 1 percent from 1.66 gallons per box. All projections of yield assume the processing relationships this season will be similar to last season.

Crop Production



ISSN: 1948-3007

Released May 12, 2014, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

Crop Progress

Corn Planted - Selected States

[These 18 States planted 91% of the 2013 corn acreage]

State	Week ending			2009-2013 Average
	May 11, 2013	May 4, 2014	May 11, 2014	
	(percent)	(percent)	(percent)	(percent)
Colorado	29	36	64	56
Illinois	16	43	78	53
Indiana	27	20	61	45
Iowa	14	23	70	70
Kansas	26	52	72	63
Kentucky	38	30	64	59
Michigan	28	3	20	41
Minnesota	16	8	31	62
Missouri	27	63	86	62
Nebraska	39	44	77	71
North Carolina	92	75	90	96
North Dakota	16	-	3	33
Ohio	40	9	40	48
Pennsylvania	45	8	27	41
South Dakota	33	26	52	43
Tennessee	62	68	87	78
Texas	77	73	80	85
Wisconsin	13	2	20	41
18 States	28	29	59	58

- Represents zero.

Corn Emerged - Selected States

[These 18 States planted 91% of the 2013 corn acreage]

State	Week ending			2009-2013 Average
	May 11, 2013	May 4, 2014	May 11, 2014	
	(percent)	(percent)	(percent)	(percent)
Colorado	1	1	4	9
Illinois	2	8	36	32
Indiana	3	2	14	28
Iowa	1	9	9	29
Kansas	5	19	35	30
Kentucky	21	15	32	45
Michigan	1	-	1	10
Minnesota	-	-	-	18
Missouri	14	29	53	40
Nebraska	2	7	16	21
North Carolina	83	55	70	84
North Dakota	-	-	-	6
Ohio	2	2	3	21
Pennsylvania	8	-	7	12
South Dakota	1	1	4	9
Tennessee	36	43	53	52
Texas	66	58	65	69
Wisconsin	-	-	-	6
18 States	5	7	18	25

- Represents zero.

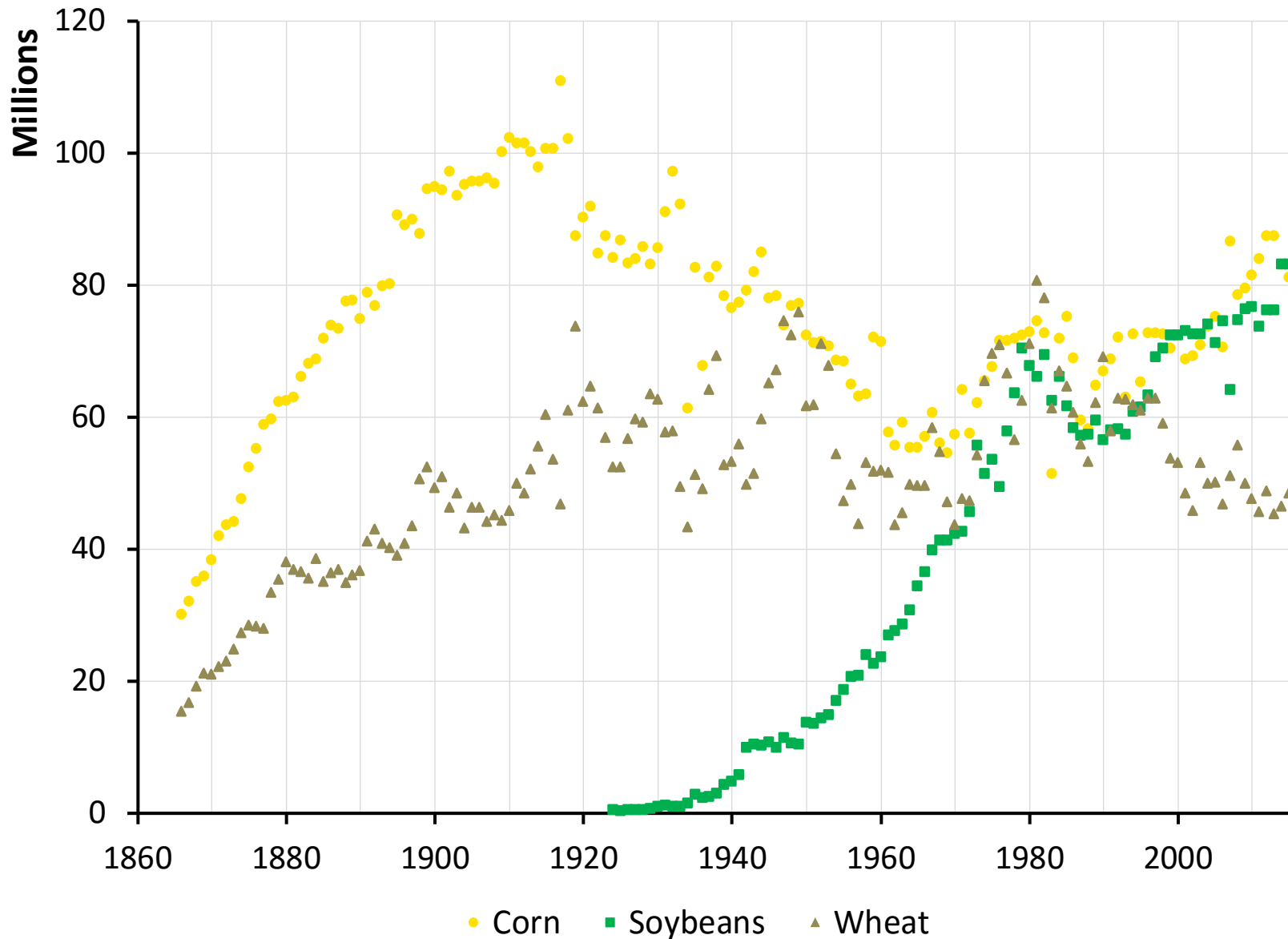
Annually – end of June

Monthly - noon ~ 10th day

Weekly – 4PM Mondays

Area trends of the top three US crops

United States Harvested Area (acres)

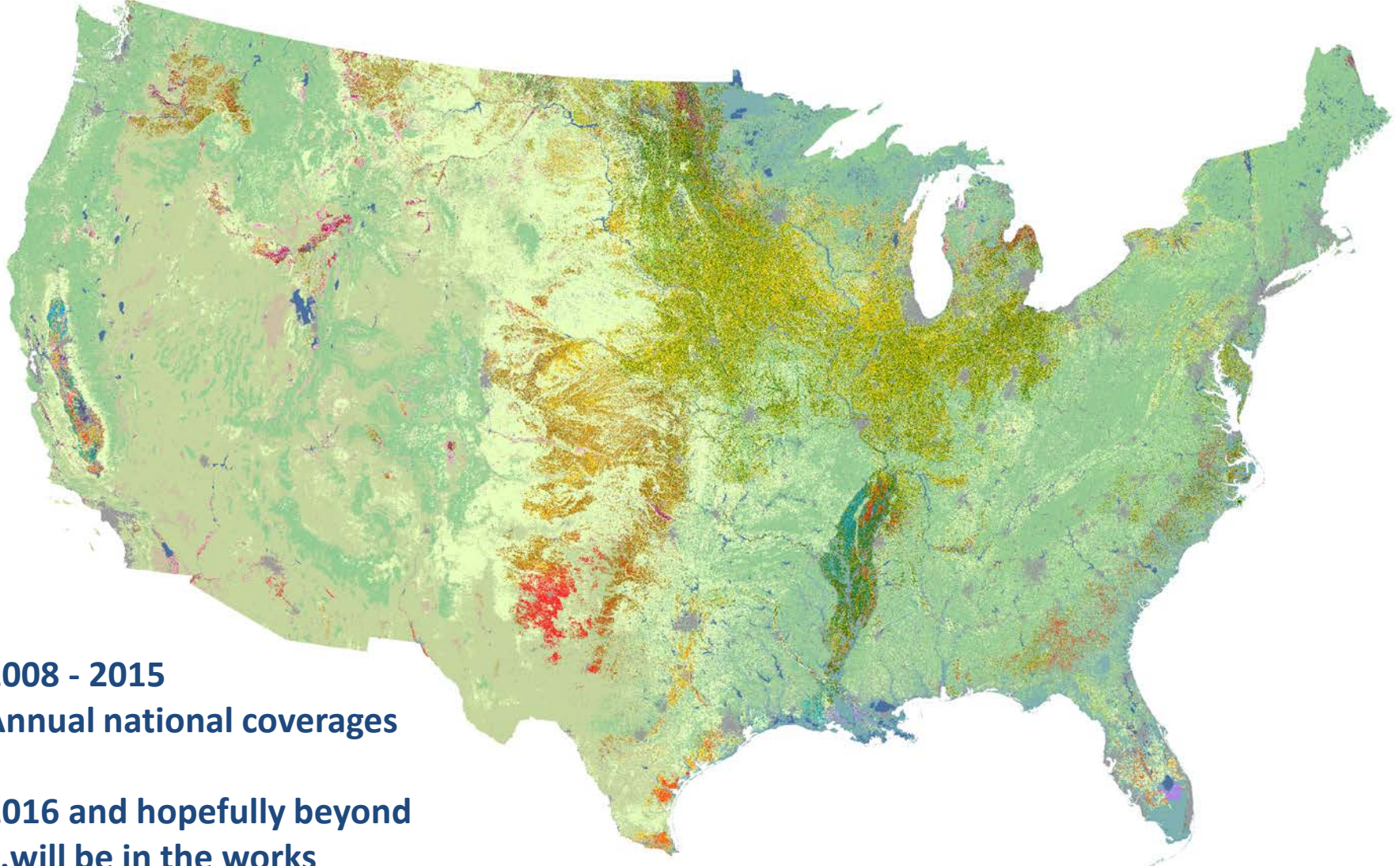
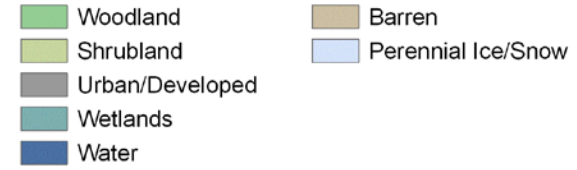


Annual land cover classification - Cropland Data Layer (CDL)

Agriculture



Non-Agriculture



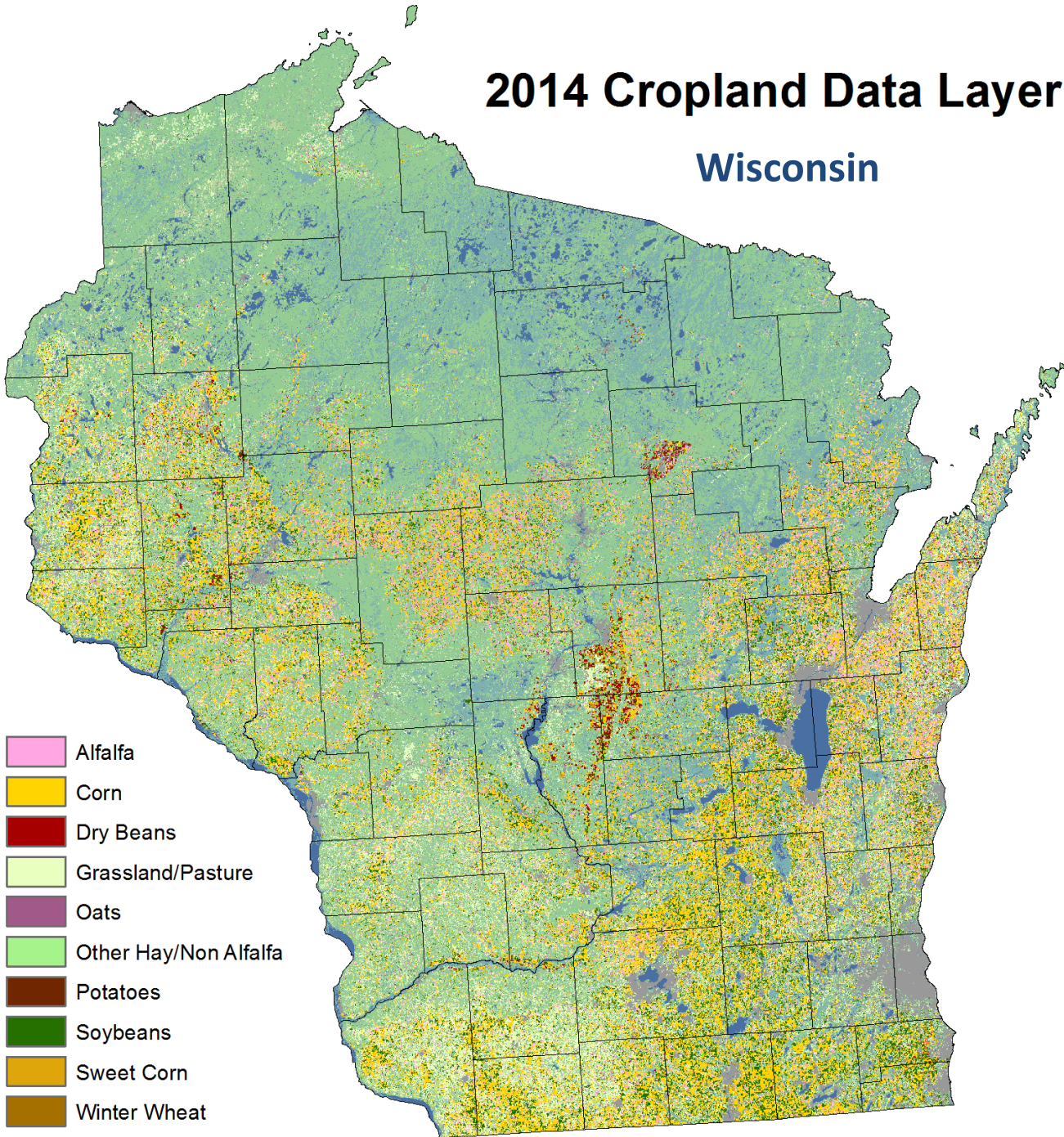
2008 - 2015

Annual national coverages

**2016 and hopefully beyond
...will be in the works**

2014 Cropland Data Layer

Wisconsin



- Alfalfa
- Corn
- Dry Beans
- Grassland/Pasture
- Oats
- Other Hay/Non Alfalfa
- Potatoes
- Soybeans
- Sweet Corn
- Winter Wheat

County-level example

2010 Cropland Data Layer McLean County, IL

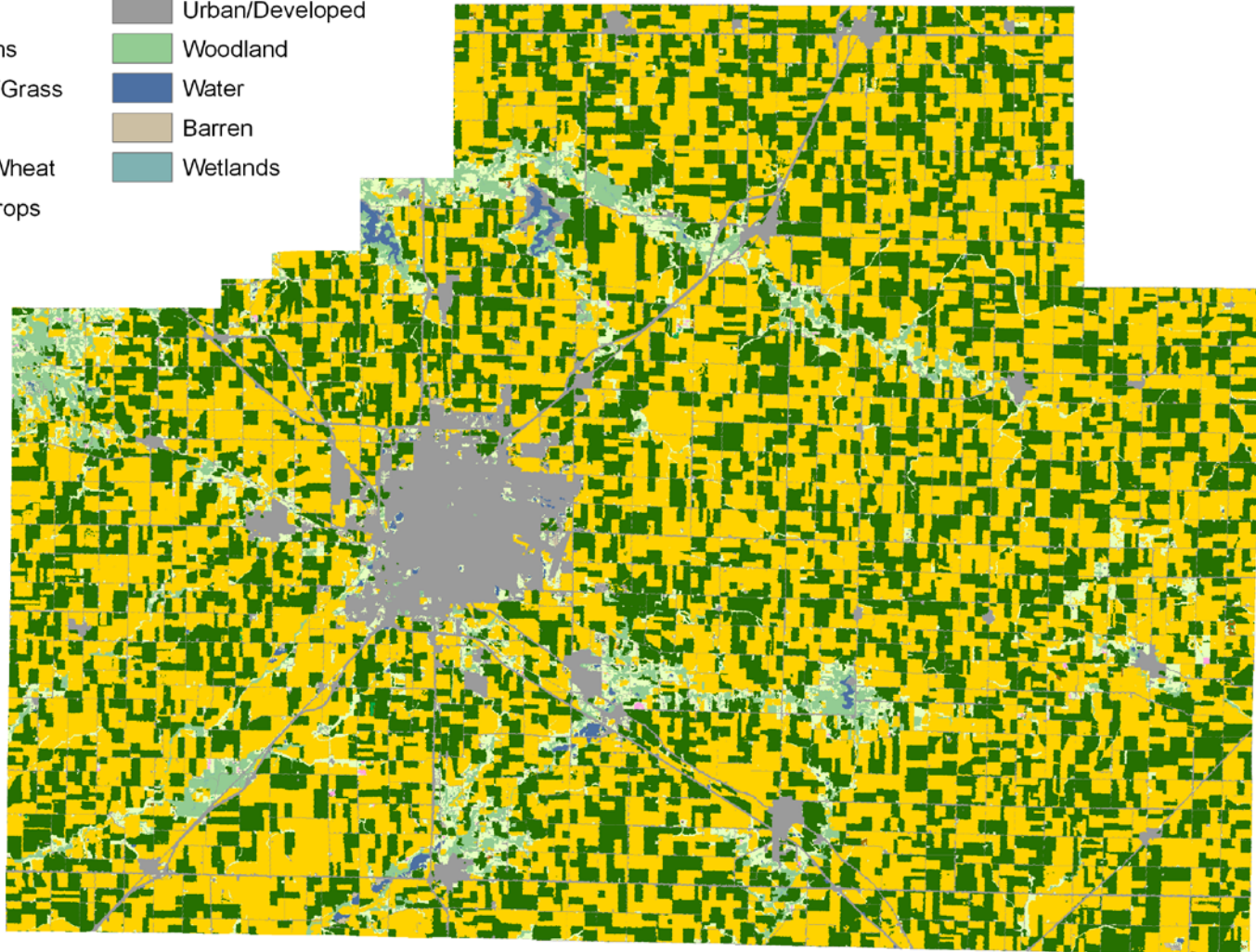
Land Cover Categories
(by decreasing acreage)

Agriculture

- Corn
- Soybeans
- Pasture/Grass
- Alfalfa
- Winter Wheat
- Other Crops

Non-Agriculture

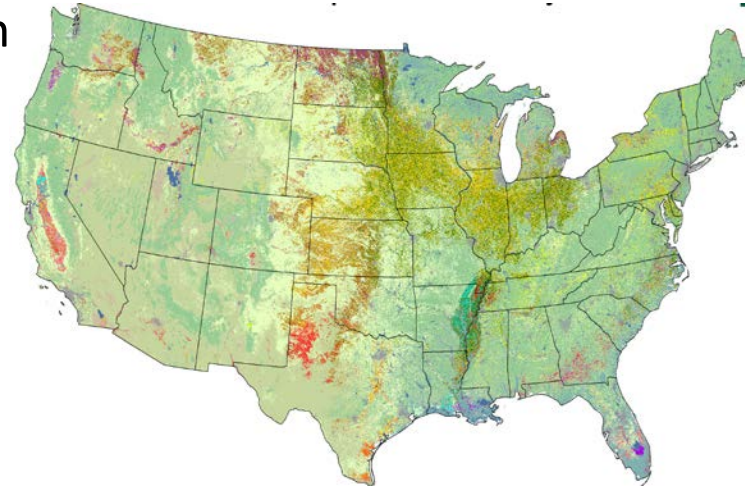
- Urban/Developed
- Woodland
- Water
- Barren
- Wetlands



CDL overview

Annual land cover classification identifying *circa* summer cultivated crops
Used internally by NASS to refine published planted acreage estimates

- Encompasses conterminous USA
 - fully since 2008
 - many states have longer history
- 56m or 30m resolution
 - year dependent
 - since 2010 30m
- Built with a “supervised boosted classification”
 - Implemented with Rulequest See 5.0
- Utilizes ground/training data from
 - USDA Farm Service Agency (FSA) data
 - National Land Cover Database (NLCD)
- Derived primarily from
 - Landsat-8 OLI and TIRS
 - DMC Deimos-1 and UK-2
 - In past used Resourcesat-1 AWIFS and Landsat 5 TM
- Highly robust for dominant crop types
 - corn, soybeans, wheat, rice, cotton, etc.
- Useful for a variety of field-level analyses



Landsat 8 Optical Land Imager

A new era

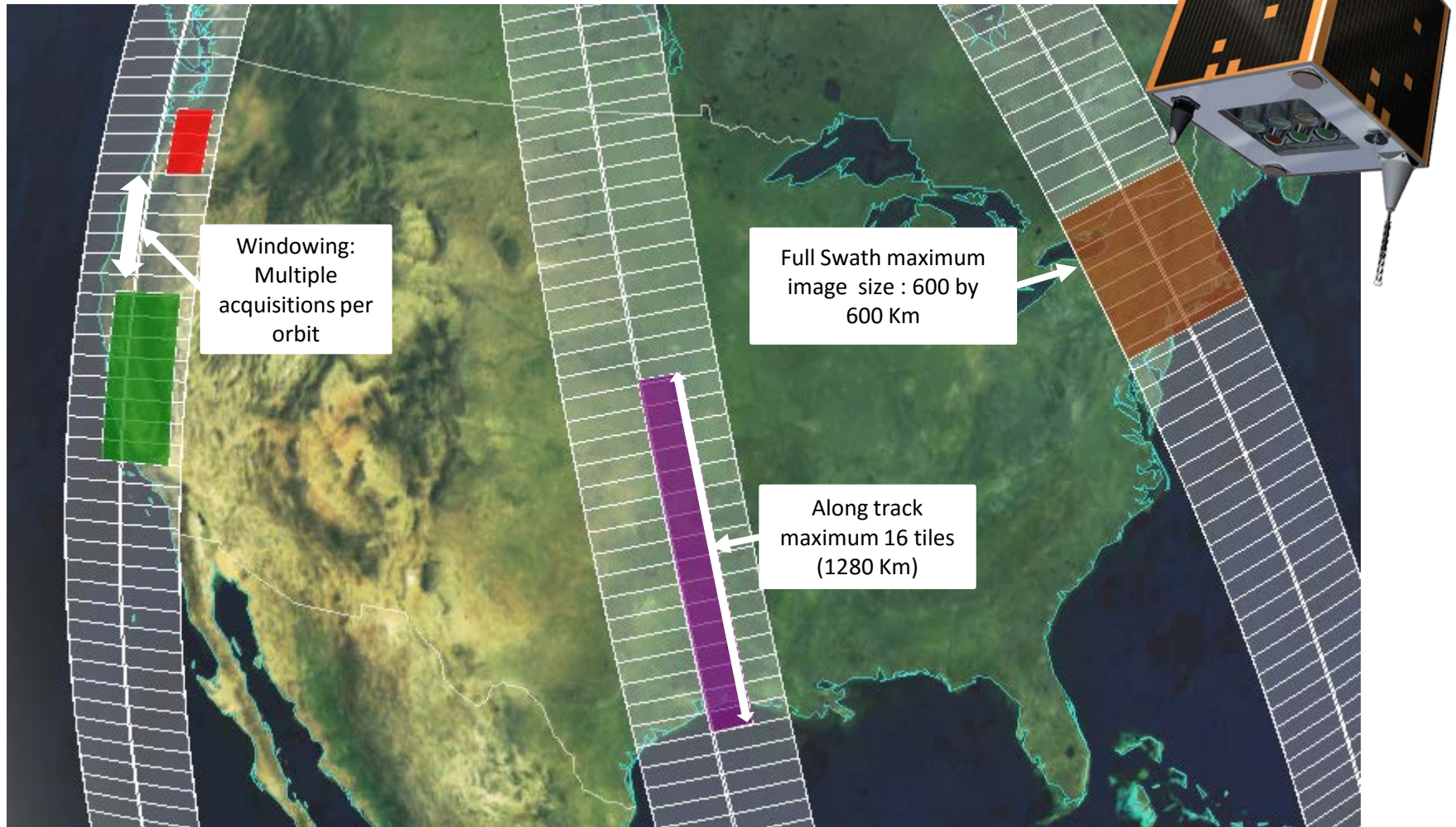


- Launched February 11, 2013
- Imagery FREE to anyone
- 30 meter spatial resolution
- 10 multispectral bands
- 16-day revisit rate
- Long history (40 years) of continuity

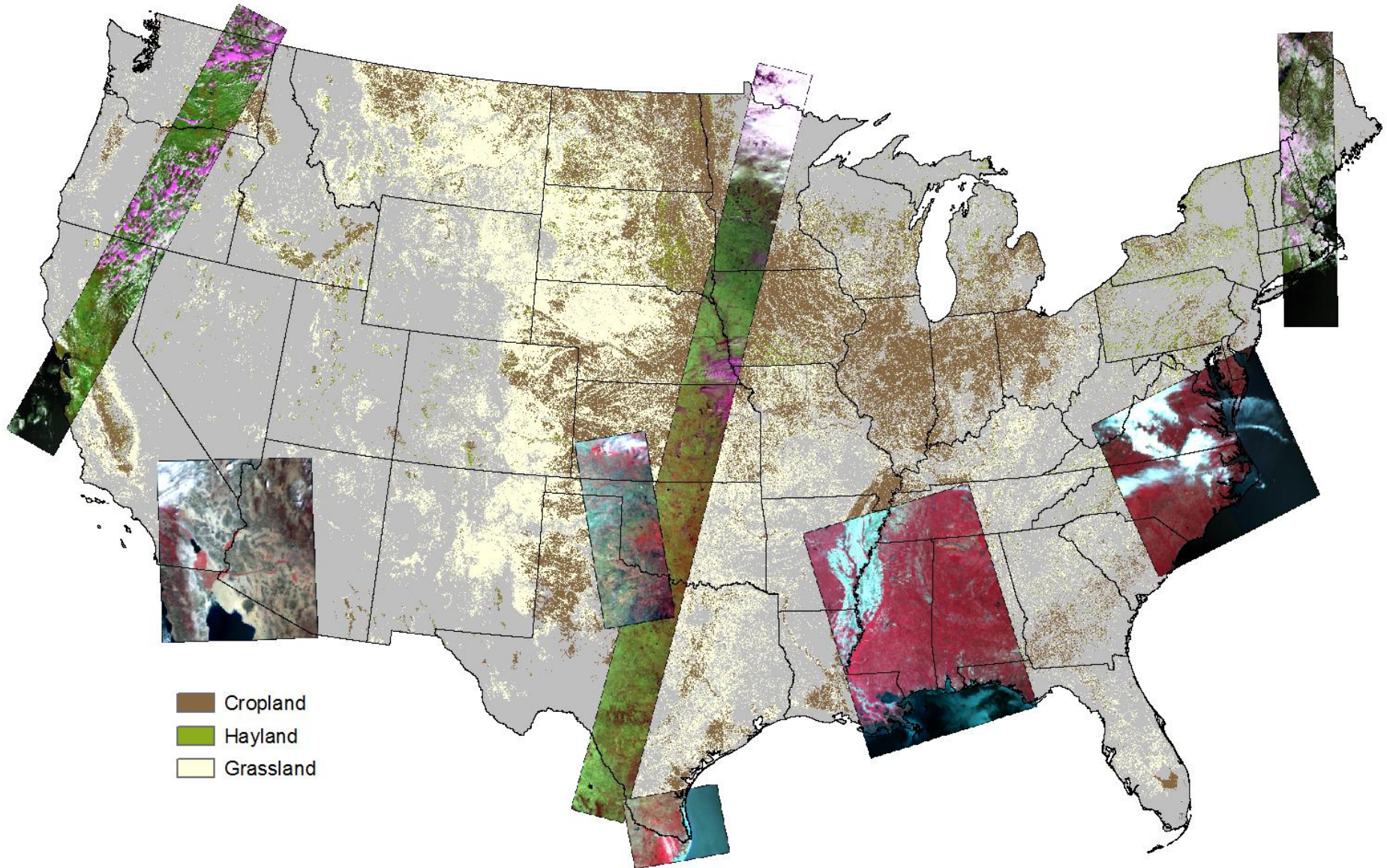


Disaster Monitoring Constellation (DMC) satellites Deimos-1 and UK2

Low cost “smallsat” with color-infrared 22m resolution

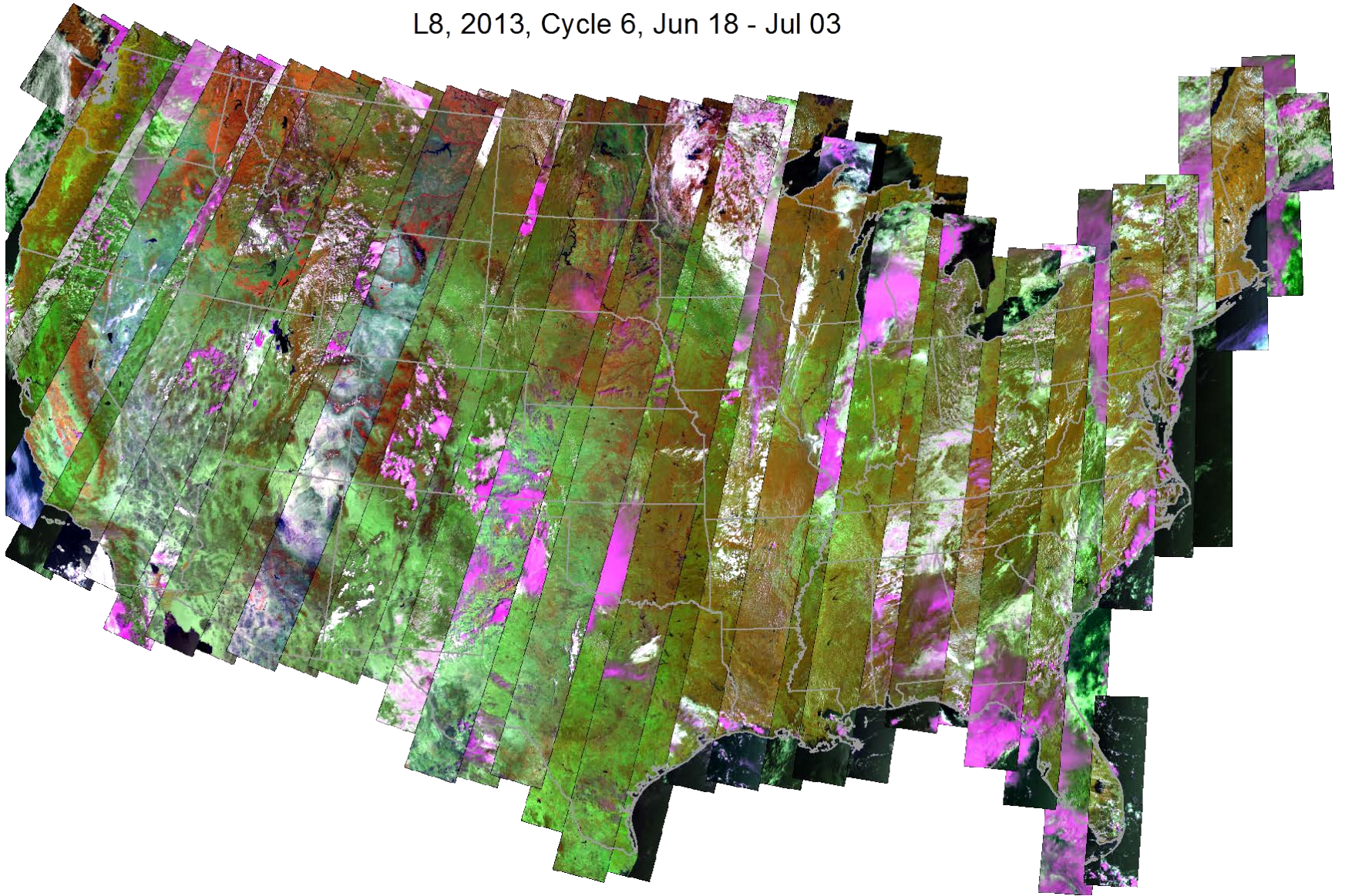


Single day of collects, 5 May 2014

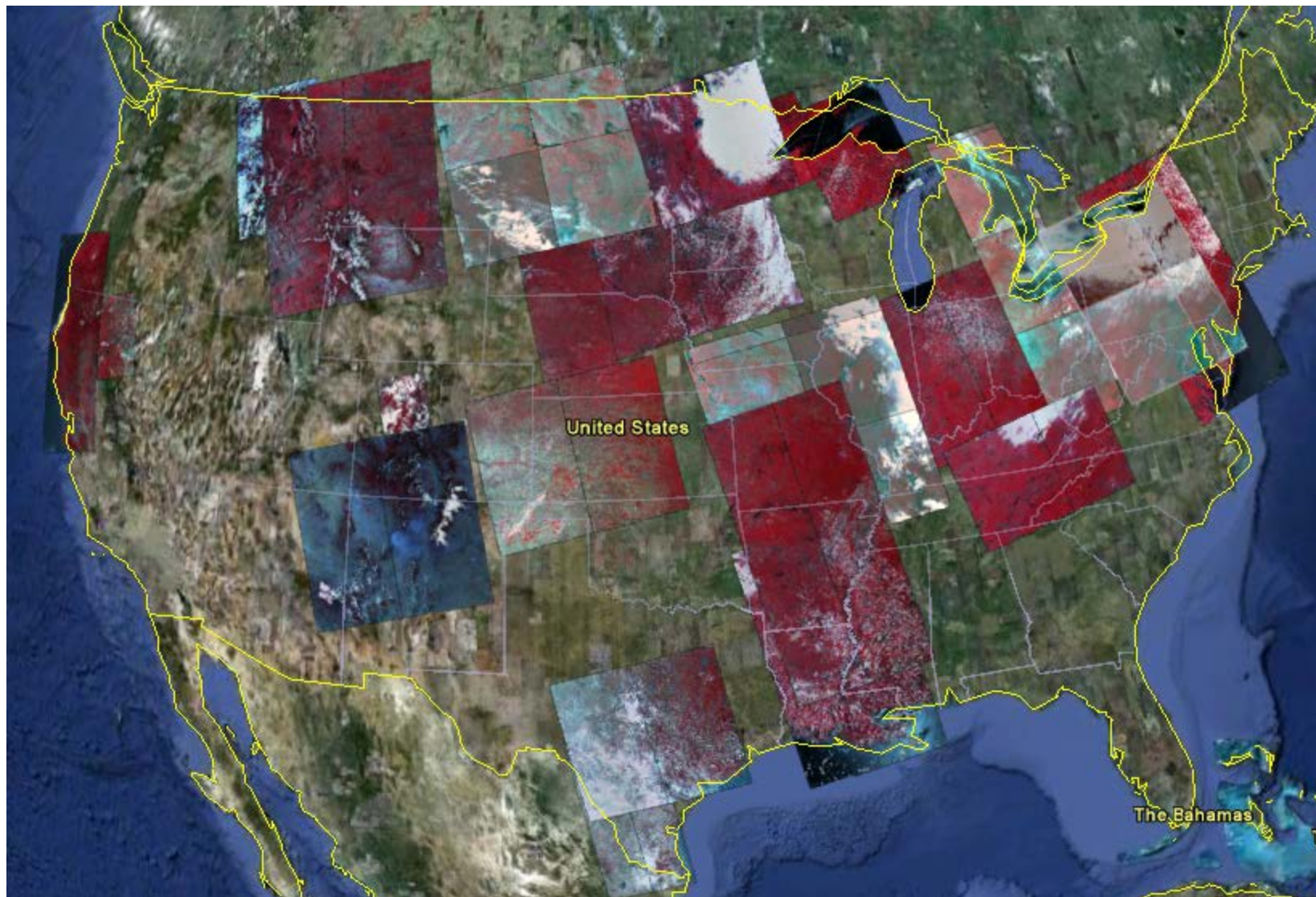


Landsat 8 collections

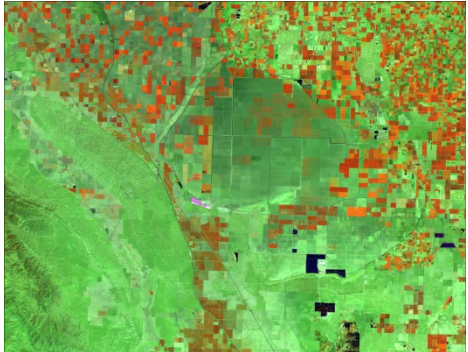
L8, 2013, Cycle 6, Jun 18 - Jul 03



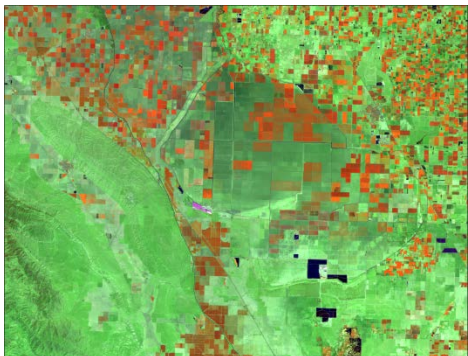
Example DMC Deimos-1 and UK2 collections



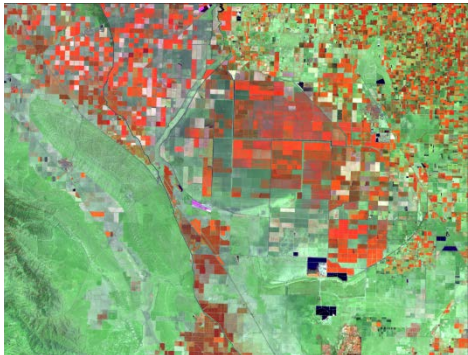
April



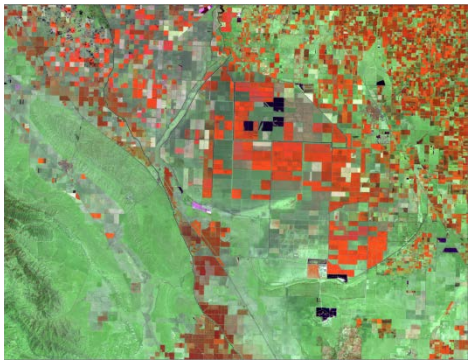
May



June



July

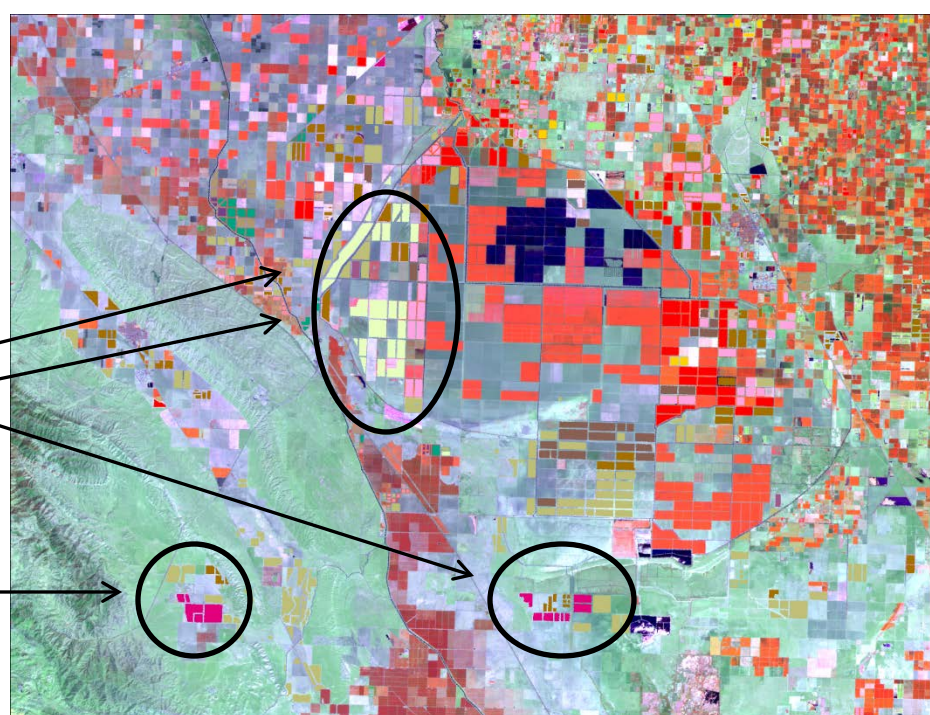


**August
with farm
Data
overlaid**

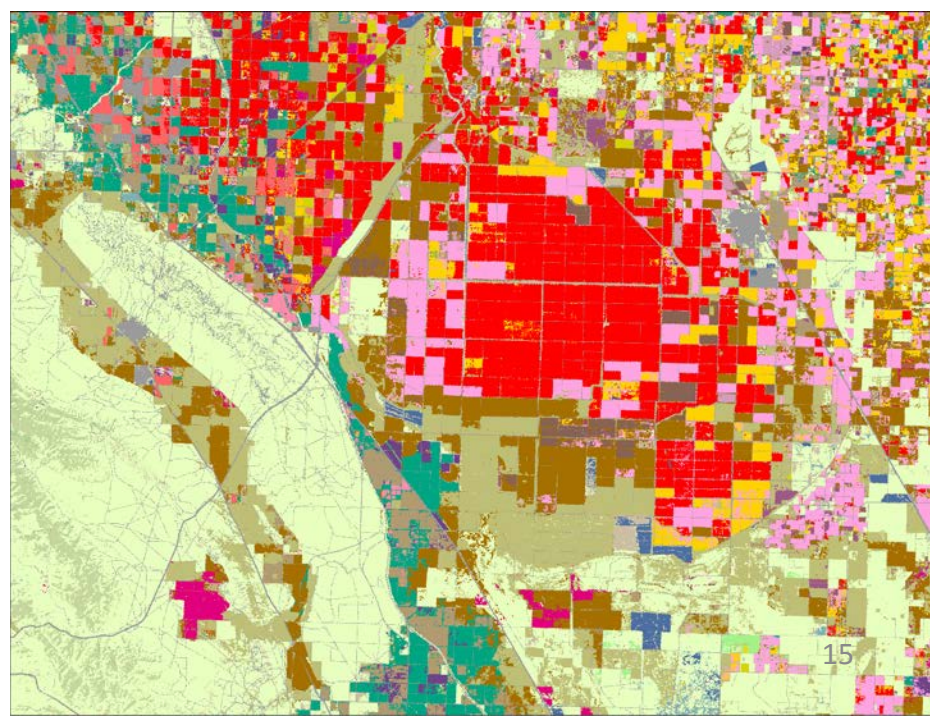
Land Cover Categories

Agriculture

-  Pasture/Grass
-  Alfalfa
-  Fallow/Idle Cropland
-  Winter Wheat
-  Barley
-  Cotton
-  Almonds
-  Corn
-  Durum Wheat



**Final
CDL**



Regression Estimation of Area

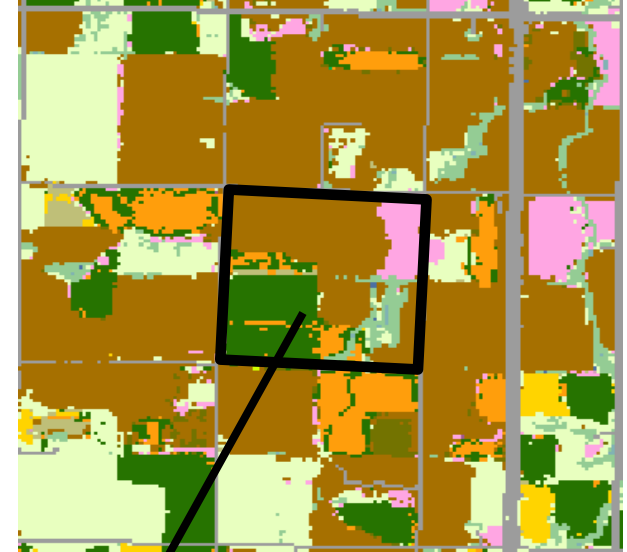
Comparing classification area to that enumerated

PAGE 2 SECTION D - CROPS AND LAND USE ON TRACT 1

How many acres are inside this blue tract boundary drawn on the photo (map)?

Now I would like to ask about each field inside this blue tract boundary and its use during 2000.

FIELD NUMBER	01	02	03	04	05
1. Total acres in field	828	828	828	828	828
2. Crop or land use. (Specify)					
3. Occupied farmstead or dwelling	843				
4. Waste, unoccupied dwellings, buildings and structures, roads, ditches, etc.					
5. Woodland	831	831	831	831	831
6. Pasture	Permanent (not in crop rotation)	842	842	842	842
	Cropland (used only for pasture)	856	856	856	856
7. Idle cropland - Idle all during 2000	857	857	857	857	857
8. Two crops planted in this field or two uses of the same crop. [Specify second crop or use.] Acres	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
		844	844	844	844
10. Acres left to be planted	610	610	610	610	610
11. Acres irrigated and to be irrigated [If double cropped, include acreage of each crop irrigated]	620	620	620	620	620
16. Winter Wheat (include cover crop)	Planted	540	540	540	540
	For grain or seed	541	541	541	541
18. Rye (include cover crop) (Exclude ryegrass)	Planted	547	547	547	547
	For grain or seed	548	548	548	548



REGRESSION
VARIABLES:

Dependent
Y

Independent
X

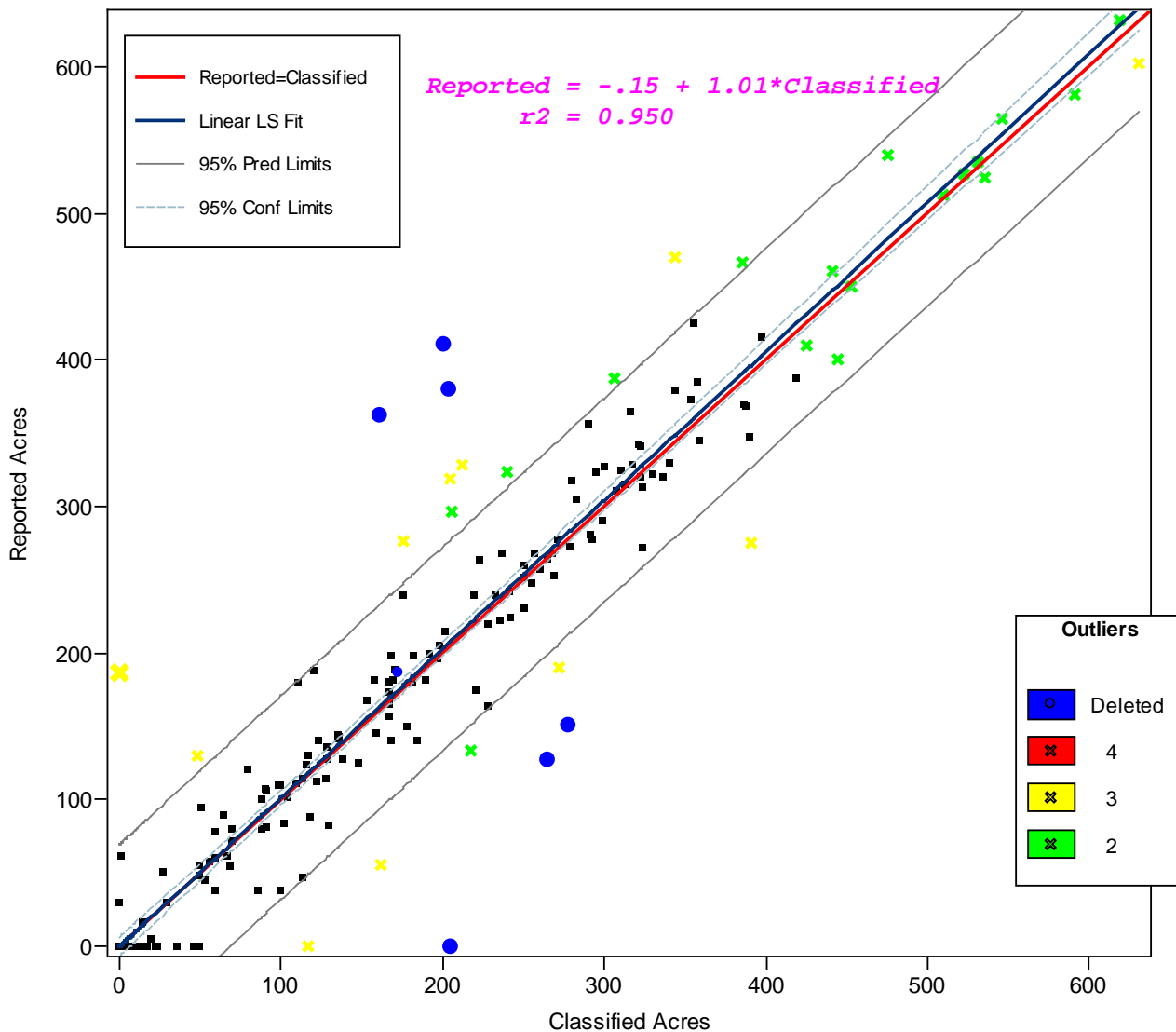
	Enumerated JAS Segments	CDL Classified Acres
Soybeans	227	273
Wheat	337	541

Relationship between reported and classified areas

Used to counteract areal bias in classification

Arkansas Rice - September

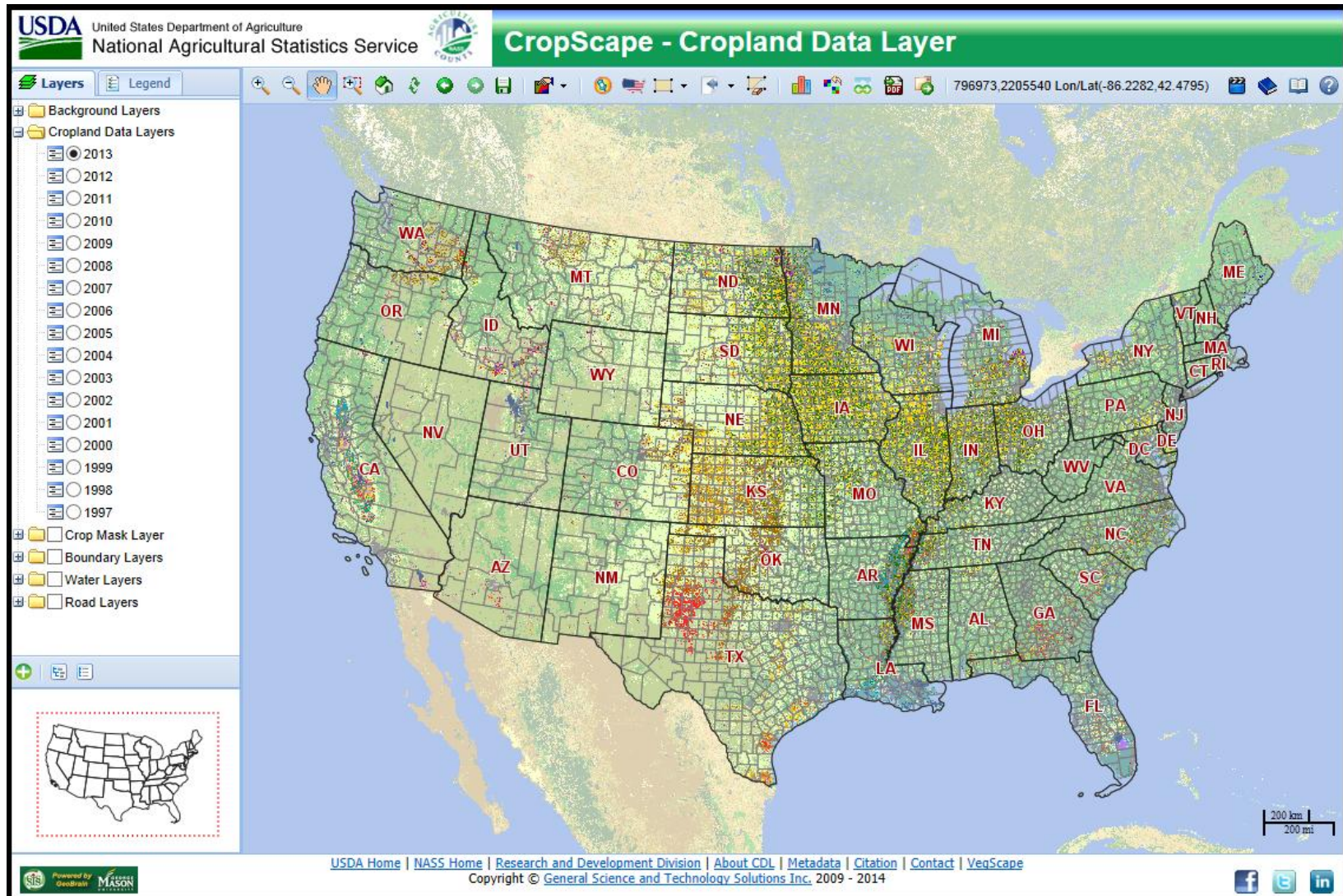
Stratum: 11 Version: v2a



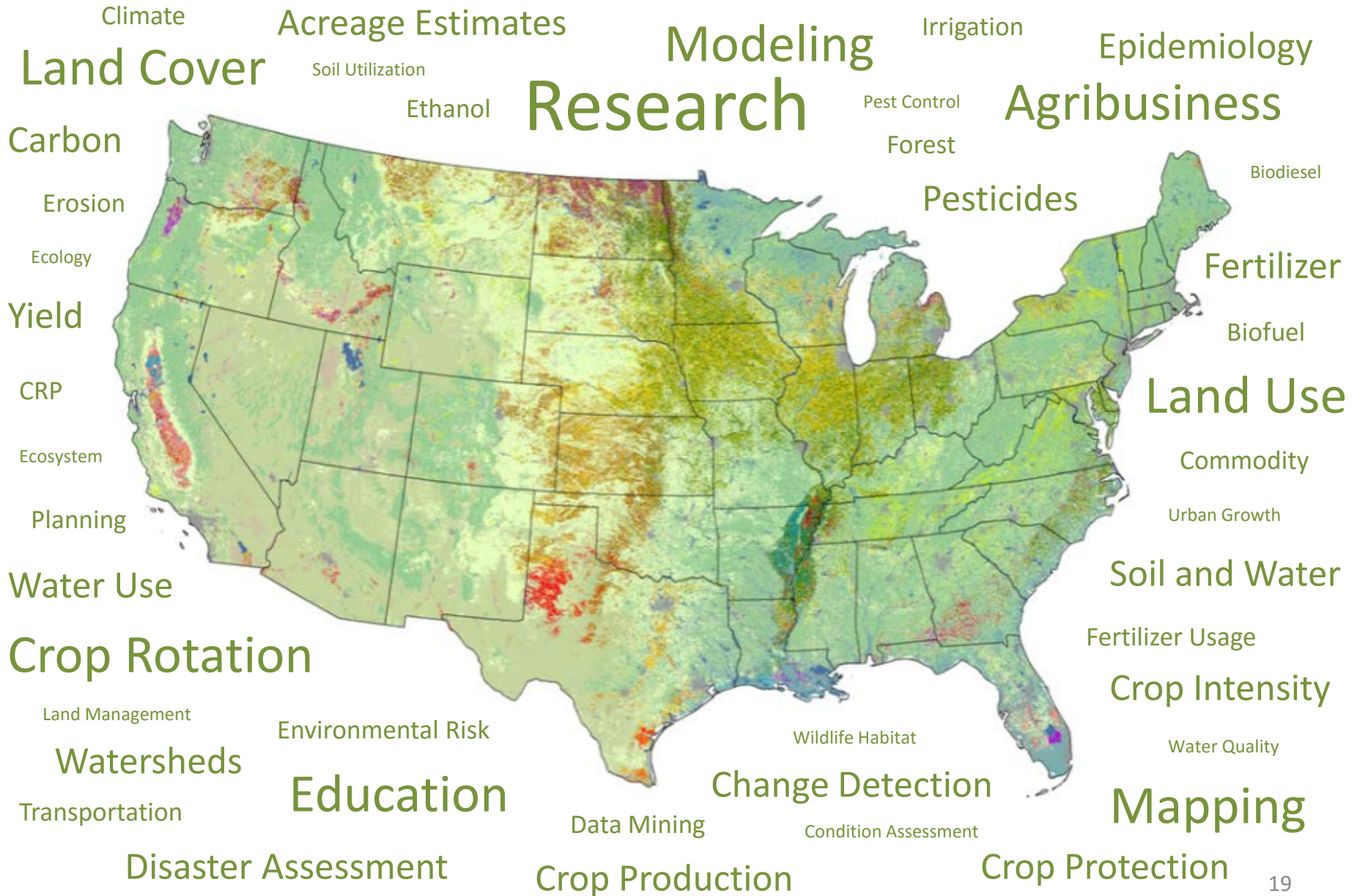
R^2
Aug - 0.948
Sep - 0.950
Oct - 0.957

Public access to CDL data

Made available online a few months after growing season complete



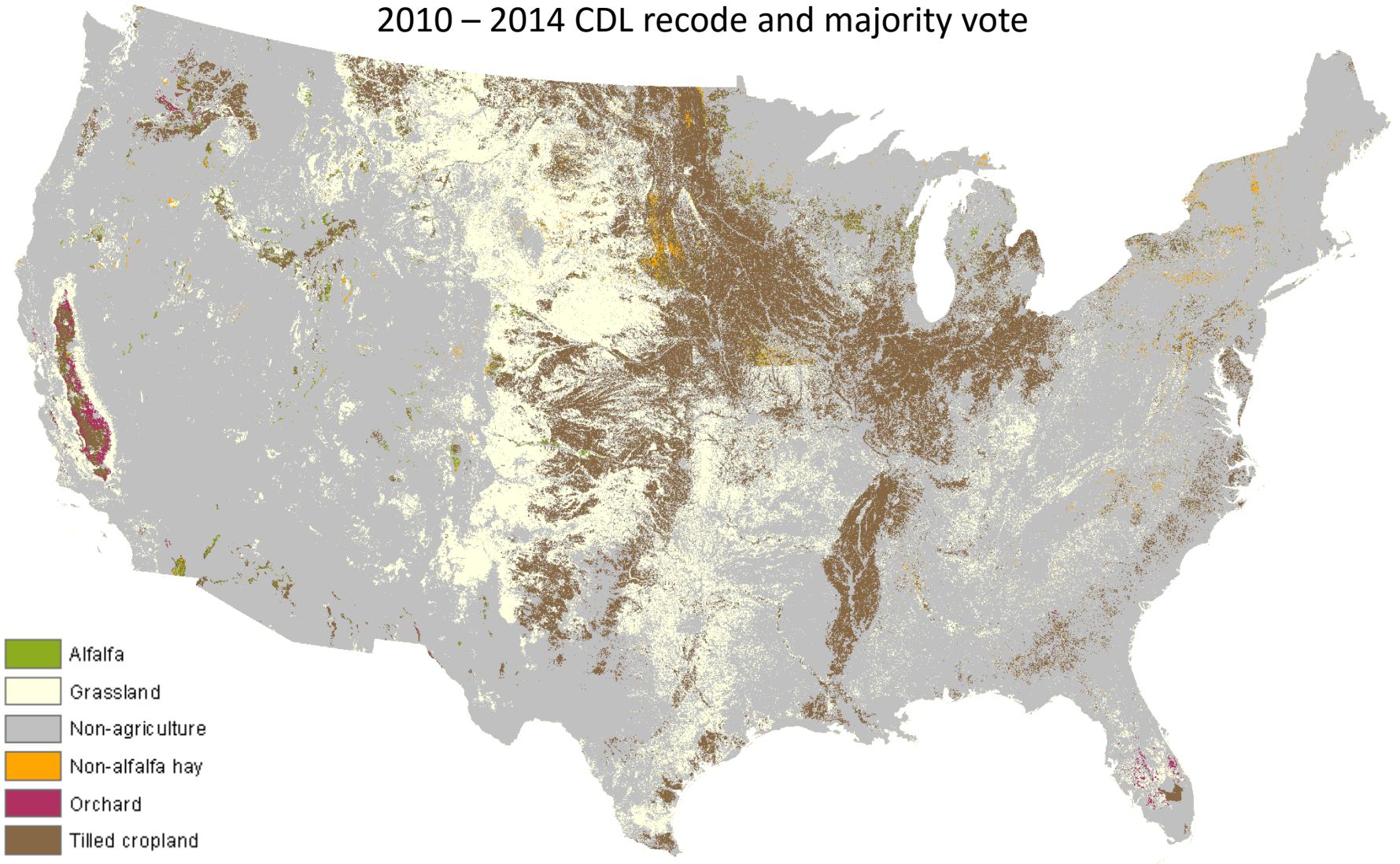
NASS Cropland Data Layer known applications



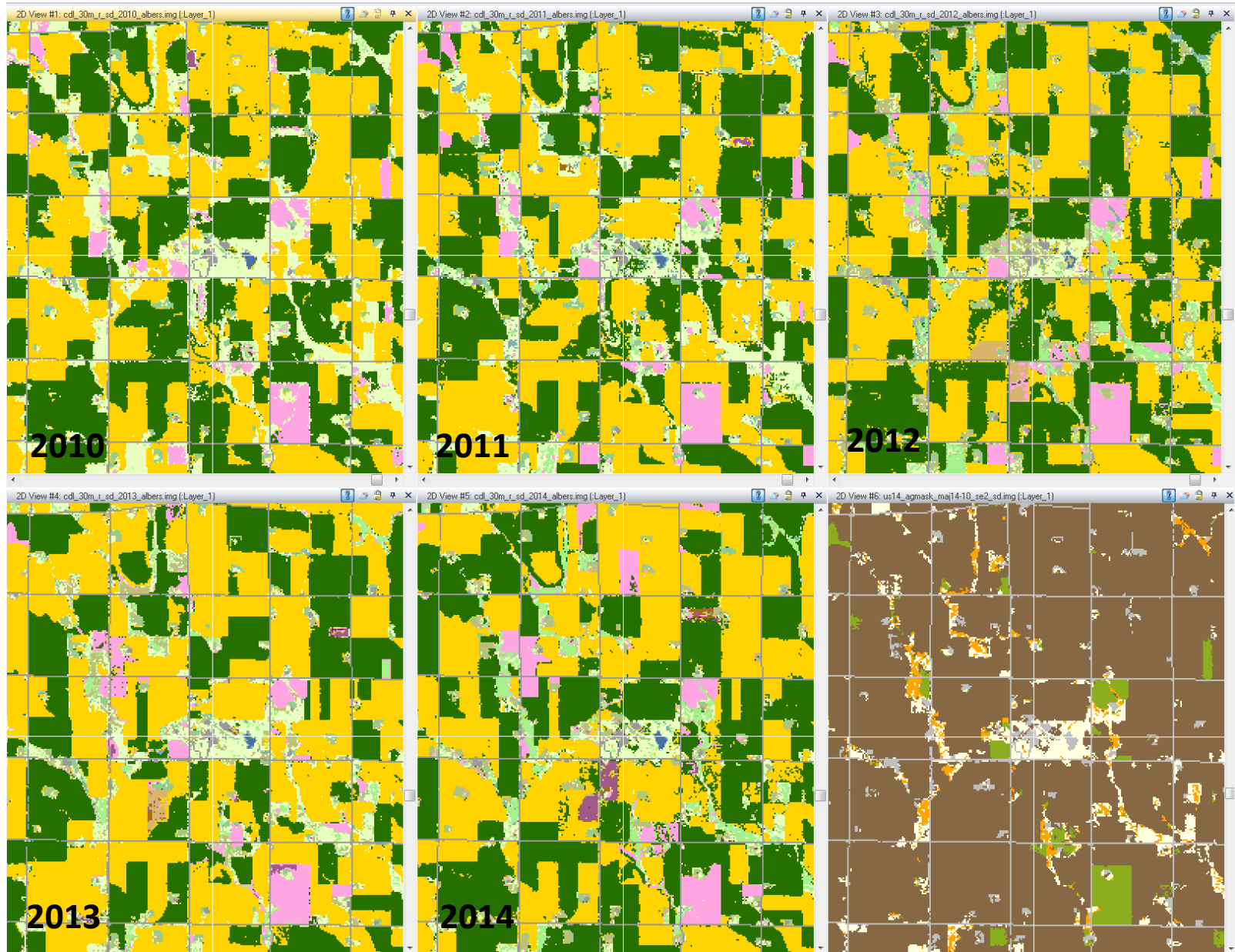
High quality crop “mask”

Emphasizing cropland, hay, and grassland areas

2010 – 2014 CDL recode and majority vote

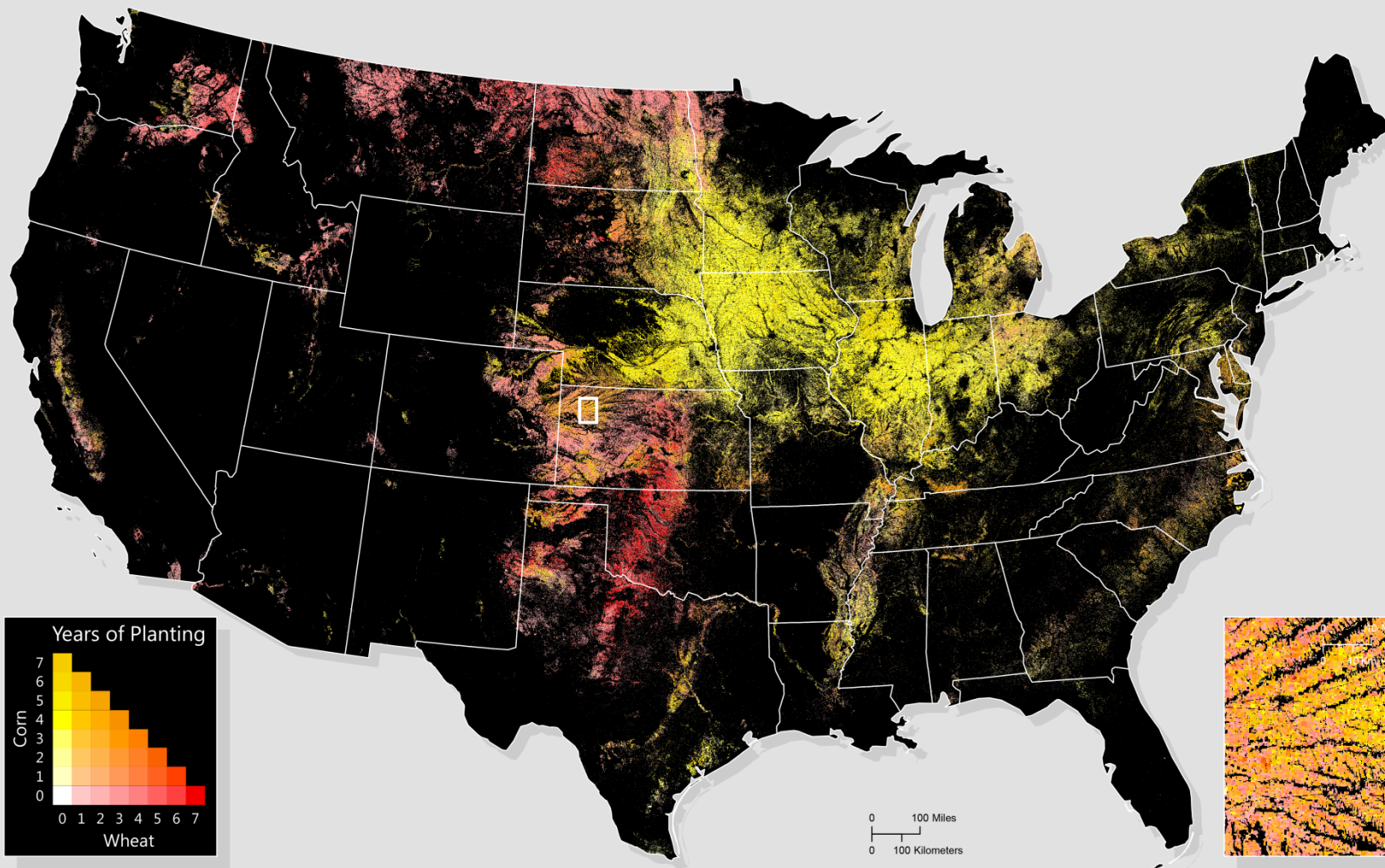


2010 – 2014 CDLs, time series analysis





Corn & Wheat Planting Frequency Data Layers 2008 - 2014

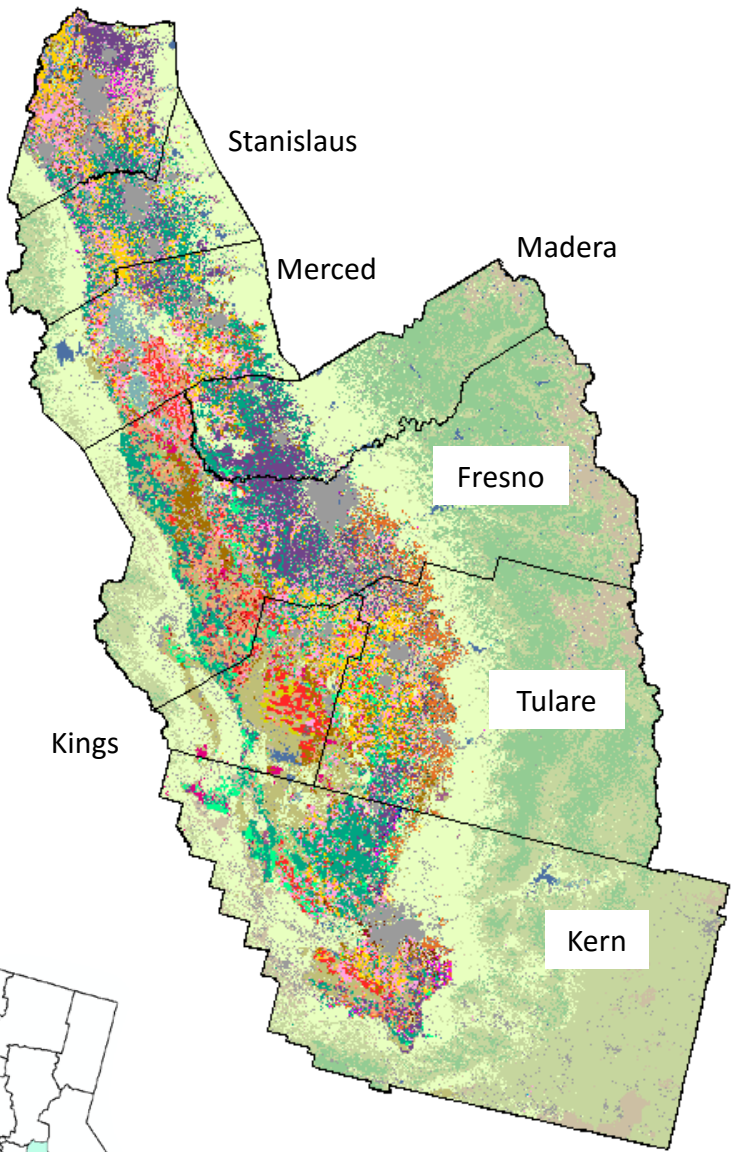


California Drought Issues

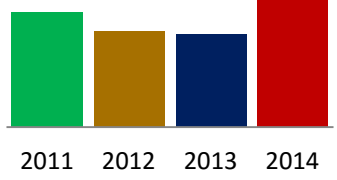
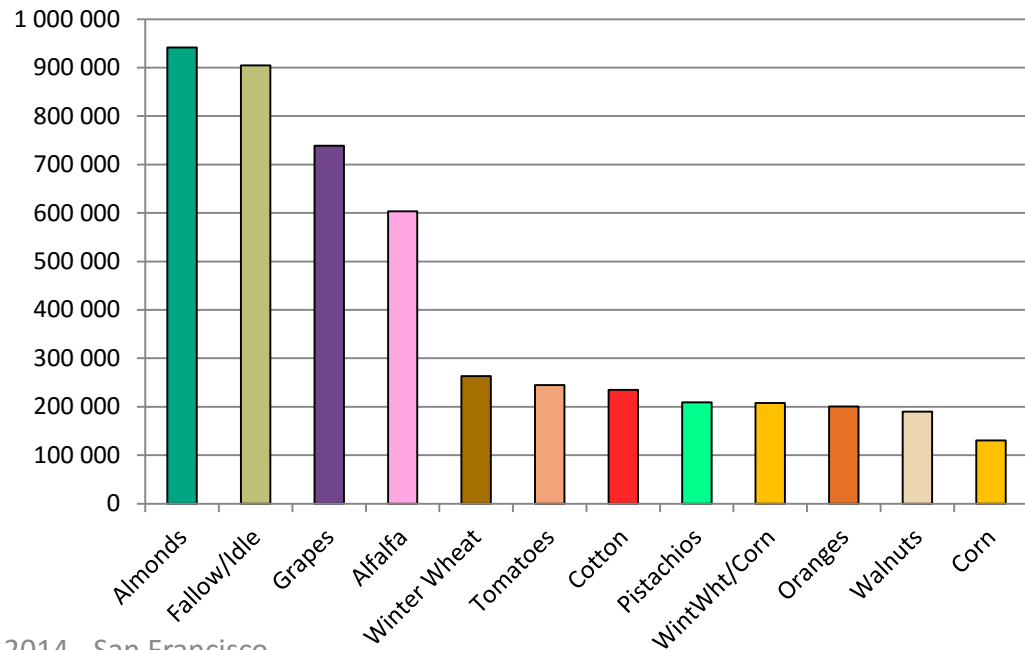
San Joaquin Valley

8 Counties with large amounts of agricultural

Investigate how the Fallow/Idle acres in each county have been changing over the last 4 years

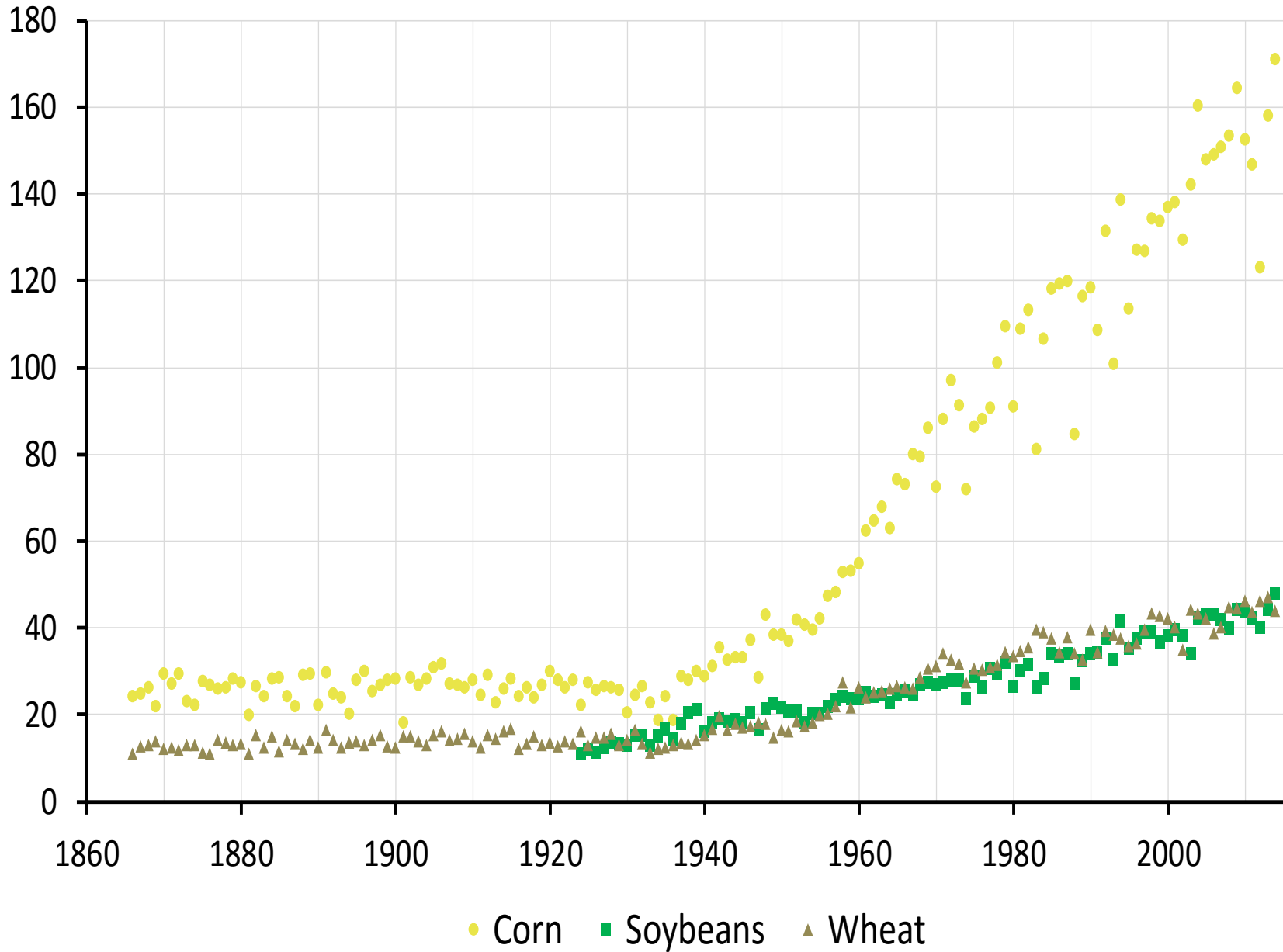


Crop Type by Acres in CDL





United States Yield (bushel/acre) Trends



Yields results primarily derived from two surveys

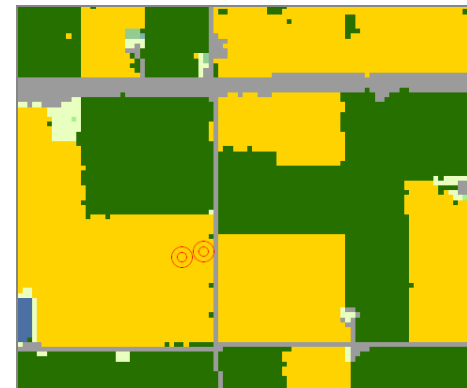
Agricultural Yield

- Farmer reported survey data of expected crop yields.
- Data obtained throughout the growing season.
- Conducted in all states except Alaska and Hawaii.
- Sample size in the 1000s per state.
- Farm operator contacts are selected from the March Crops/Stocks survey (small grains) and the June Crops/Stocks survey (late season crops and tobacco).
- Primarily telephone based.



Objective yield

- Corn, Cotton, Soybeans, Wheat, Potatoes.
- Only done in states where the commodities are primarily found.
- Samples selected from areas found in June Area Survey (“Acreage”).
- Performed at 100s of sample sites per state.
- Biophysical plant/seed measurements obtained.
- Each plot revisited a few times per season.



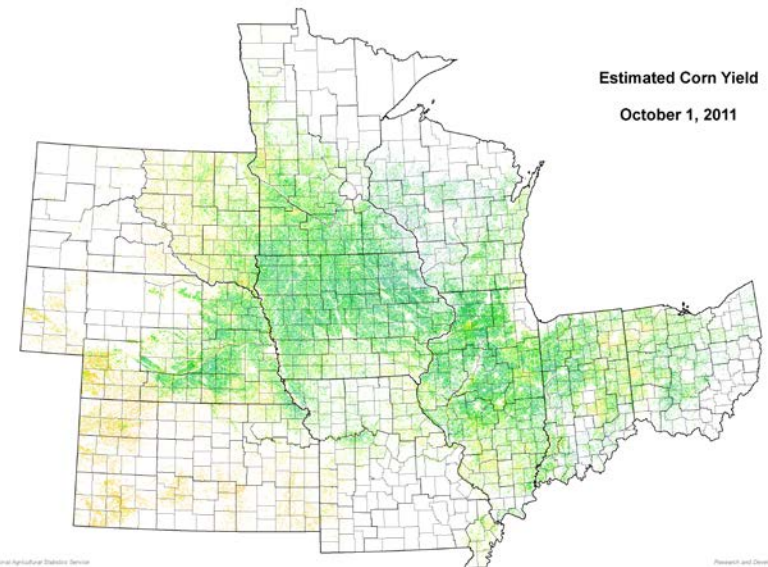
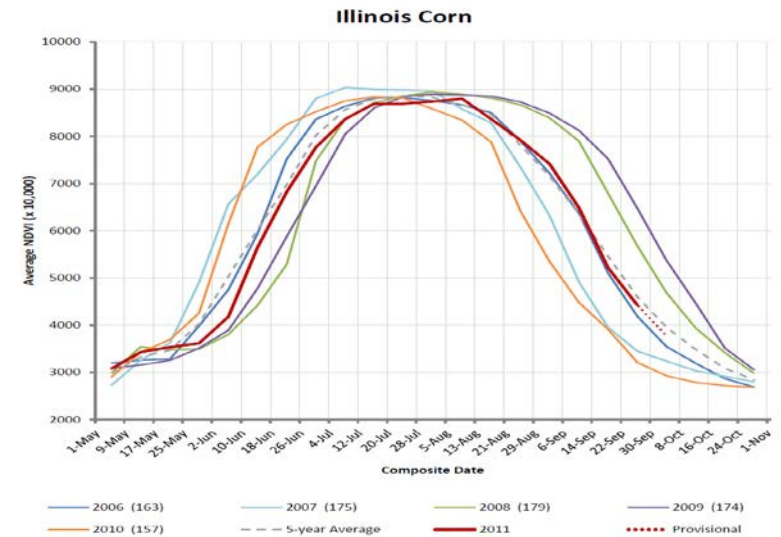
Yield Estimation from Remote Sensing Goals

For the major commodities...

- Produce August 1 national and state-level yield indications for inclusion into NASS decision making
 - Followed by September 1st, October 1st, and November 1st.
- Be independent of current years' OY and AY surveys
- Follow in January with county-level estimates
- **Undertake with marginal budget**
 - i.e. free data, cheap or existing software, mainstream computer

Remote sensing of crop yields overview

- Premise (though others' research and my own)
 - Positive relationship between crop yield and biomass – plant vigor - “greenness” - NDVI
 - Negative relationship between crop yield and land surface temperature
- Utilize time-series MODIS satellite data to obtain biomass and temperature estimates throughout the growing season
 - Then use them in an empirically-based prediction model
 - CDL data used to isolate known crop areas
- Run model at National, State, ASD, and County levels
 - Corn and Soybeans operational currently
 - Potential for several other crops too
- Must be timely in addition to being accurate
 - Collect current information and assess within a day or two



Moderate Resolution Imaging Spectroradiometer (MODIS)



A screenshot of the MODIS Web homepage. The page features the NASA logo and the text "NATIONAL AERONAUTICS AND SPACE ADMINISTRATION" at the top left. A search bar is located at the top right. The main header includes the text "MODIS" and "Web" with a background image of Earth. Below the header is a navigation menu with links for "ABOUT MODIS", "NEWS", "DATA", "IMAGES", "SCIENCE TEAM", "RELATED SITES", "SEARCH", and "MODARCH". The main content area is divided into three columns: "DATA", "IMAGES", and "DISCIPLINES". The "DATA" section contains text about the MODIS Data section. The "IMAGES" section features a satellite image of Super Typhoon Jelawat (18W) in the Philippine Sea. The "DISCIPLINES" section lists "Atmosphere", "Land", "Ocean", and "Calibration" with corresponding icons. The footer includes the "FIRST GOV" logo, "Privacy Policy and Important Notices", the NASA logo, and the names of the curators: Brandon Maccherone and Shannell Frazier.

250 m resolution, daily imagery

Calculation from surface reflectance and use of NDVI

Log in / create account

Article Discussion Read Edit View history Search

Normalized Difference Vegetation Index

From Wikipedia, the free encyclopedia

This article **reads more like a story than an encyclopedia entry**. To meet Wikipedia's **quality standards** and conform to the **neutral point of view policy**, please help to introduce a more formal style and remove any personally invested tone. *(July 2011)*

The **Normalized Difference Vegetation Index (NDVI)** is a simple graphical indicator that can be used to analyze **remote sensing** measurements, typically but not necessarily from a **space platform**, and assess whether the target being observed contains live green vegetation or not.

Contents
1 Brief history
2 Rationale
3 Performance and limitations
4 See also
5 References
6 External links

Brief history

The exploration of outer space started in earnest with the launch of **Sputnik 1** by the **Soviet Union** on 4 October 1957. This was the first man-made **satellite** orbiting the **Earth**. Subsequent successful launches, both in the Soviet Union (e.g., the **Sputnik** and **Cosmos** programs), and in the U.S. (e.g., the **Explorer program**), quickly led to the design and operation of dedicated **meteorological satellites**. These are orbiting platforms embarking instruments specially designed to observe the Earth's atmosphere and surface with a view to improve **weather forecasting**. Starting in 1960, the **TIROS** series of satellites embarked television cameras and radiometers. This was later (from 1964 onwards) followed by the **Nimbus** satellites and the family of **Advanced Very High Resolution Radiometer** instruments onboard the **National Oceanic and Atmospheric Administration (NOAA)** platforms. The latter measures the reflectance of the planet in red and near-infrared bands, as well as in the thermal infrared. In parallel, NASA developed the **Earth Resources Technology Satellite (ERTS)**, which became the precursor to the **Landsat program**. These early sensors had minimal spectral resolution, but tended to include bands

Negative values of NDVI (values approaching -1) correspond to water. Values close to zero (-0.1 to 0.1) generally correspond to barren areas of rock, sand, or snow. Lastly, low, positive values represent shrub and grassland (approximately 0.2 to 0.4), while high values indicate temperate and tropical rainforests (values approaching 1).^[1]

average NDVI of June 2003

NDVI in June over the British Isles (NOAA AVHRR)

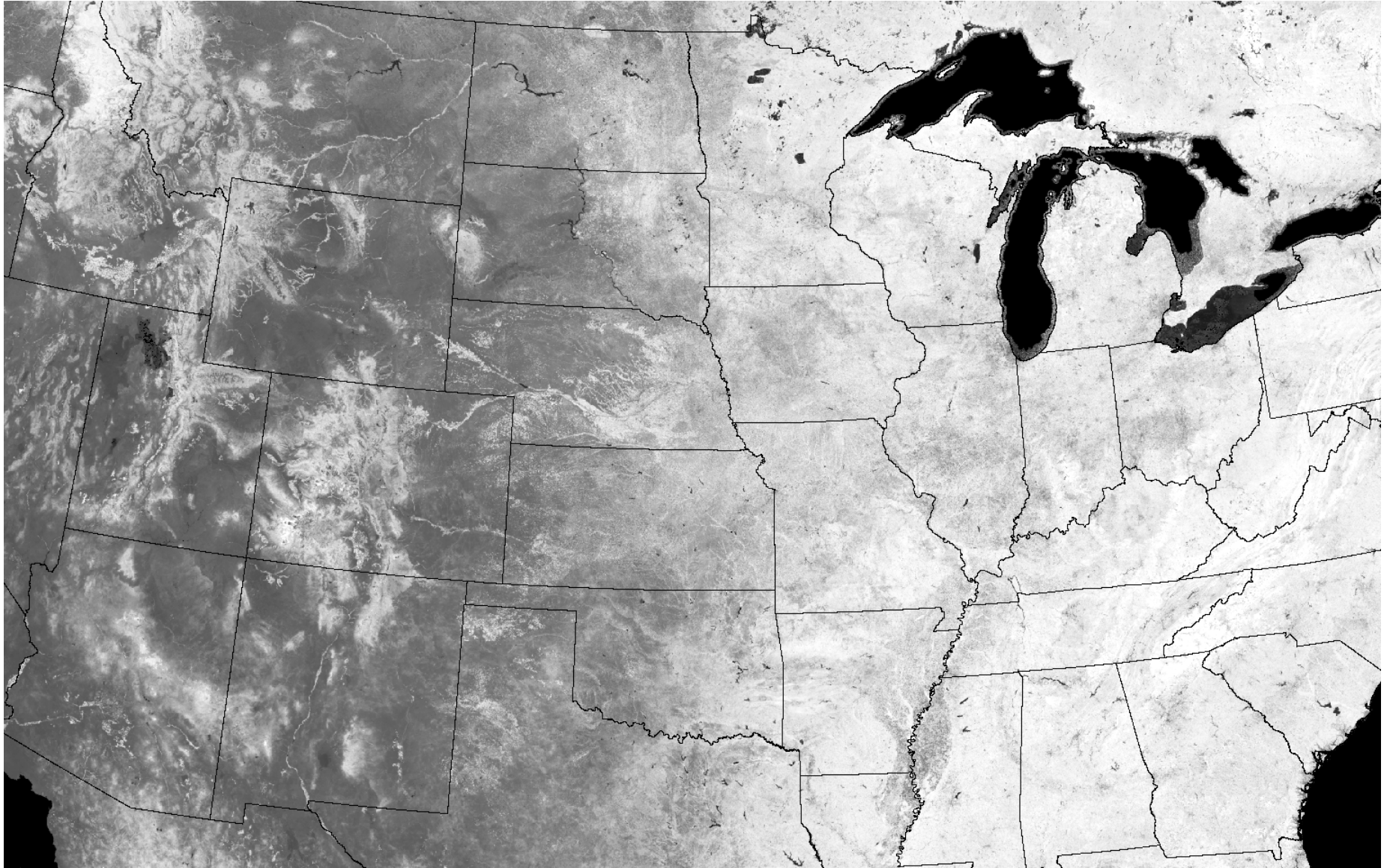
$$\text{NDVI} = \frac{(\text{NIR} - \text{VIS})}{(\text{NIR} + \text{VIS})}$$

NIR = near-infrared
VIS = visible

Ranges from -1.0 to 1.0

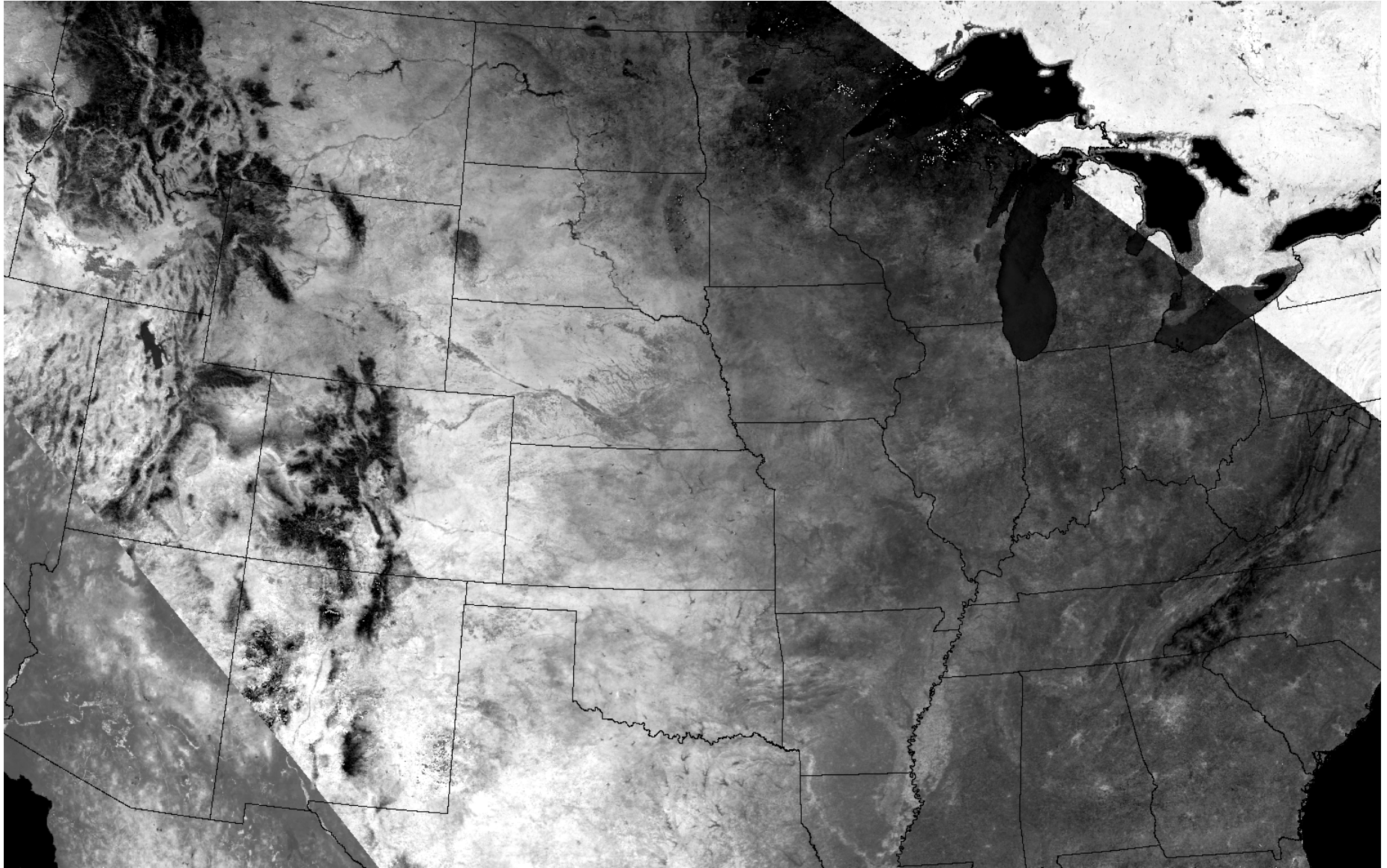
- NDVI is a related to
- Plant health
 - Chlorophyll content
 - “Greenness”
 - Biomass
 - Vegetation vigor

MODIS NDVI 8-day composite example



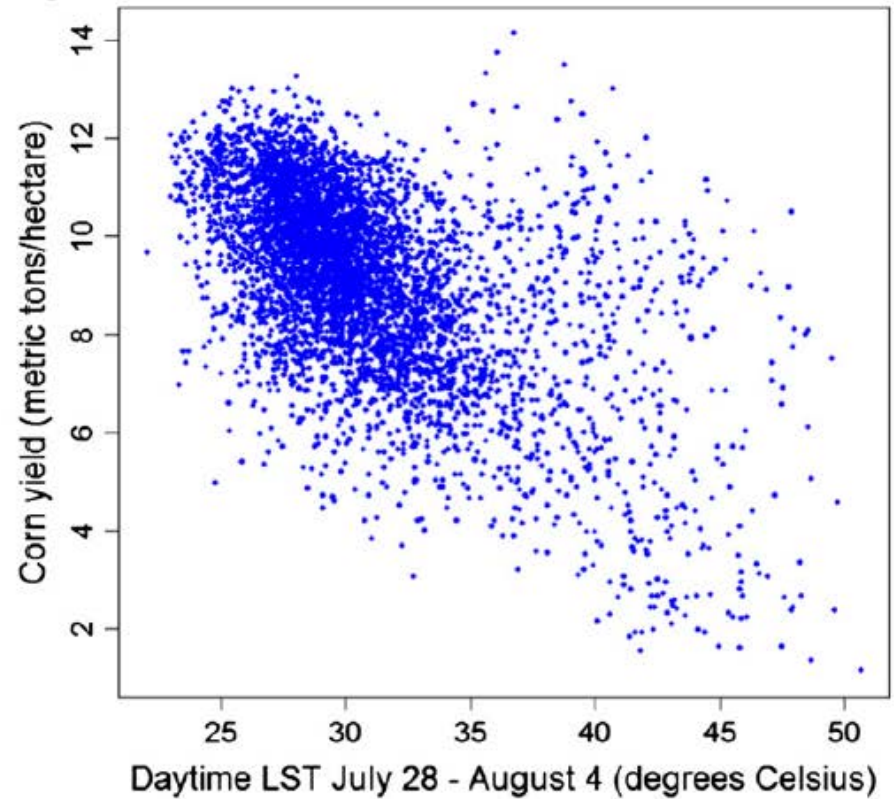
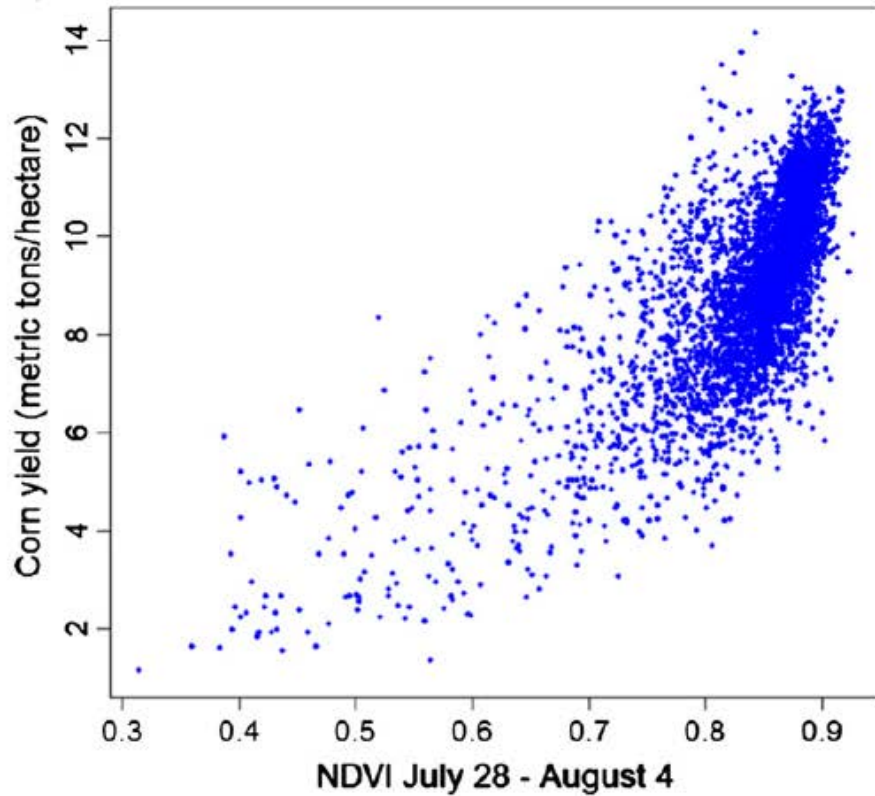
Lighter shades, greater NDVI

MODIS surface temperature 8-day composite example

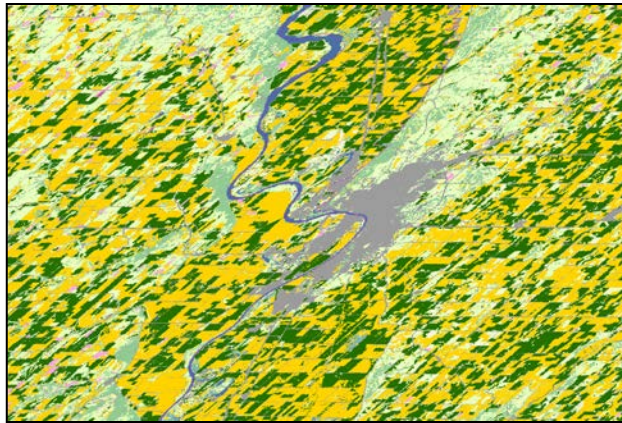


Lighter shades, greater land surface temperature

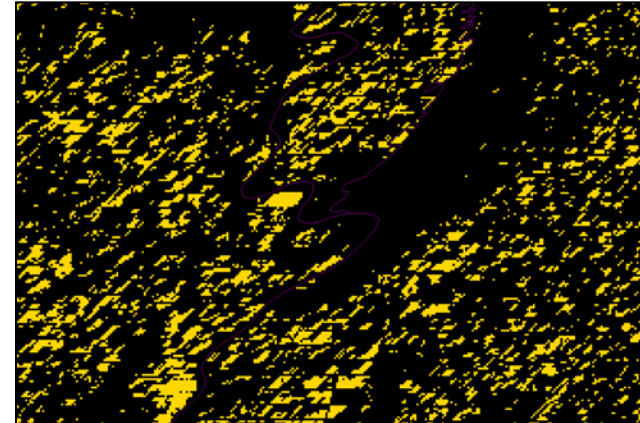
The relationships (mid summer) to corn yields



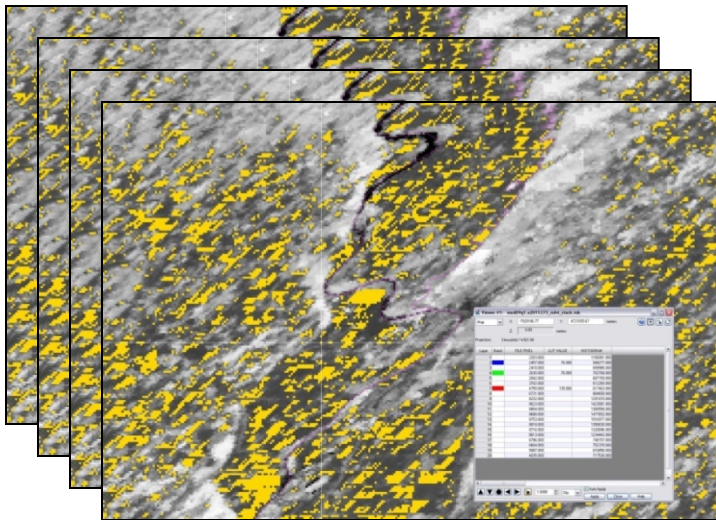
Intersecting of crop “mask” with time-series of MODIS data



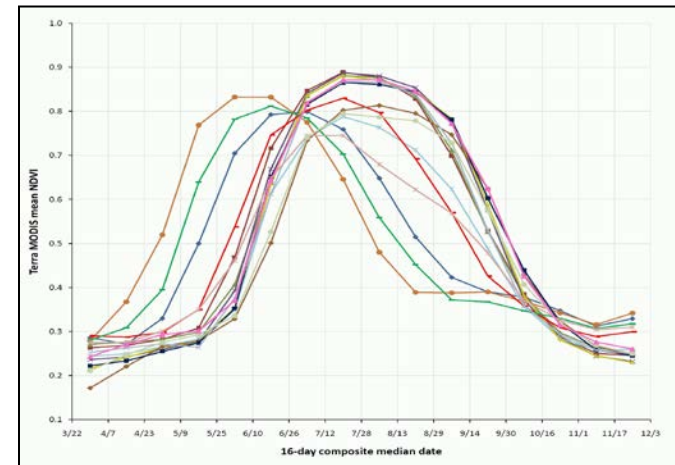
CDL



Isolate crop of interest

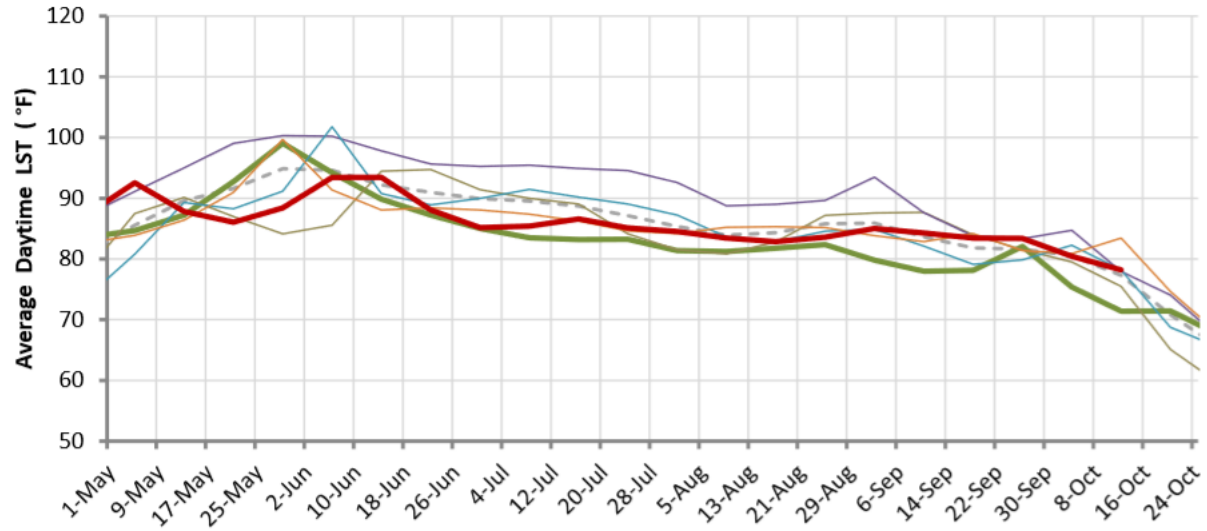


Intersect crop mask with MODIS time series and then spatially average those pixels

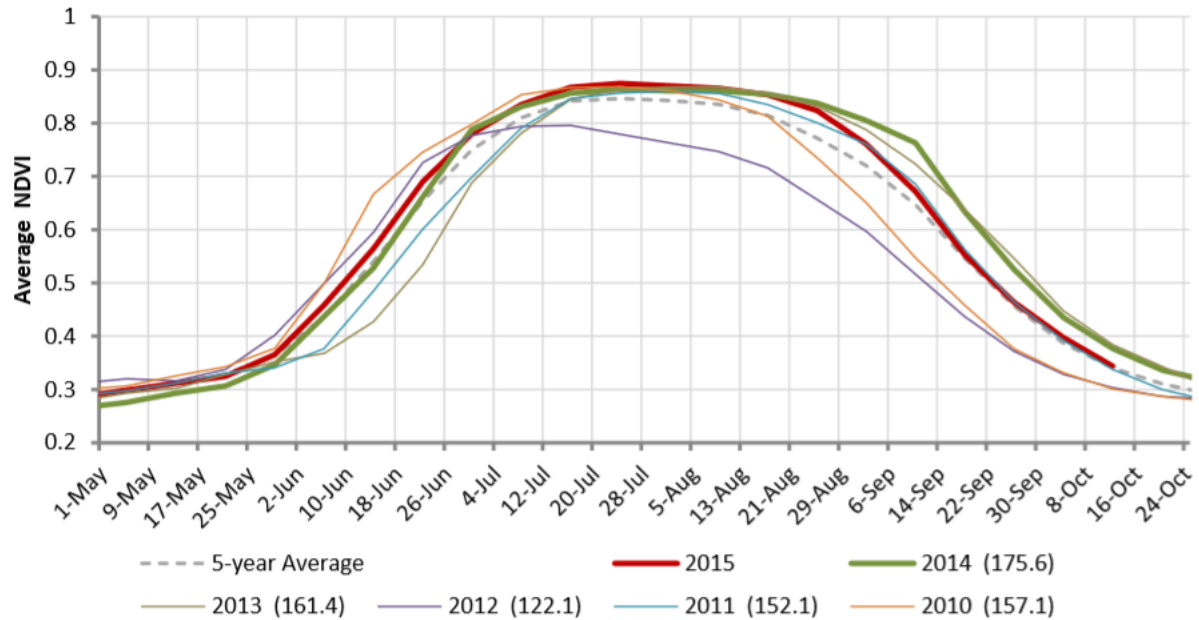


Speculative Region - Corn

Daytime Land Surface Temperature (LST)

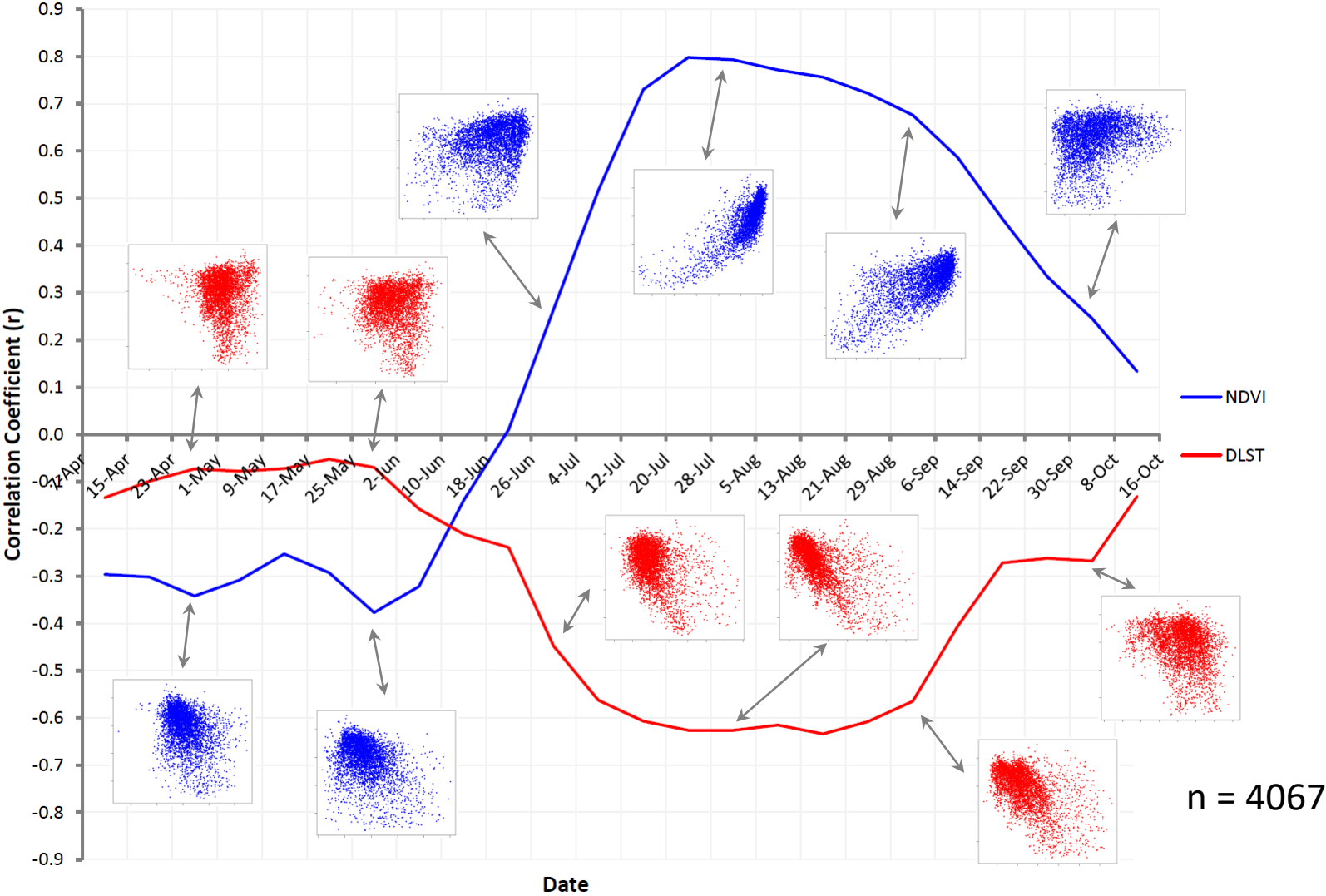


Normalized Difference Vegetation Index (NDVI)

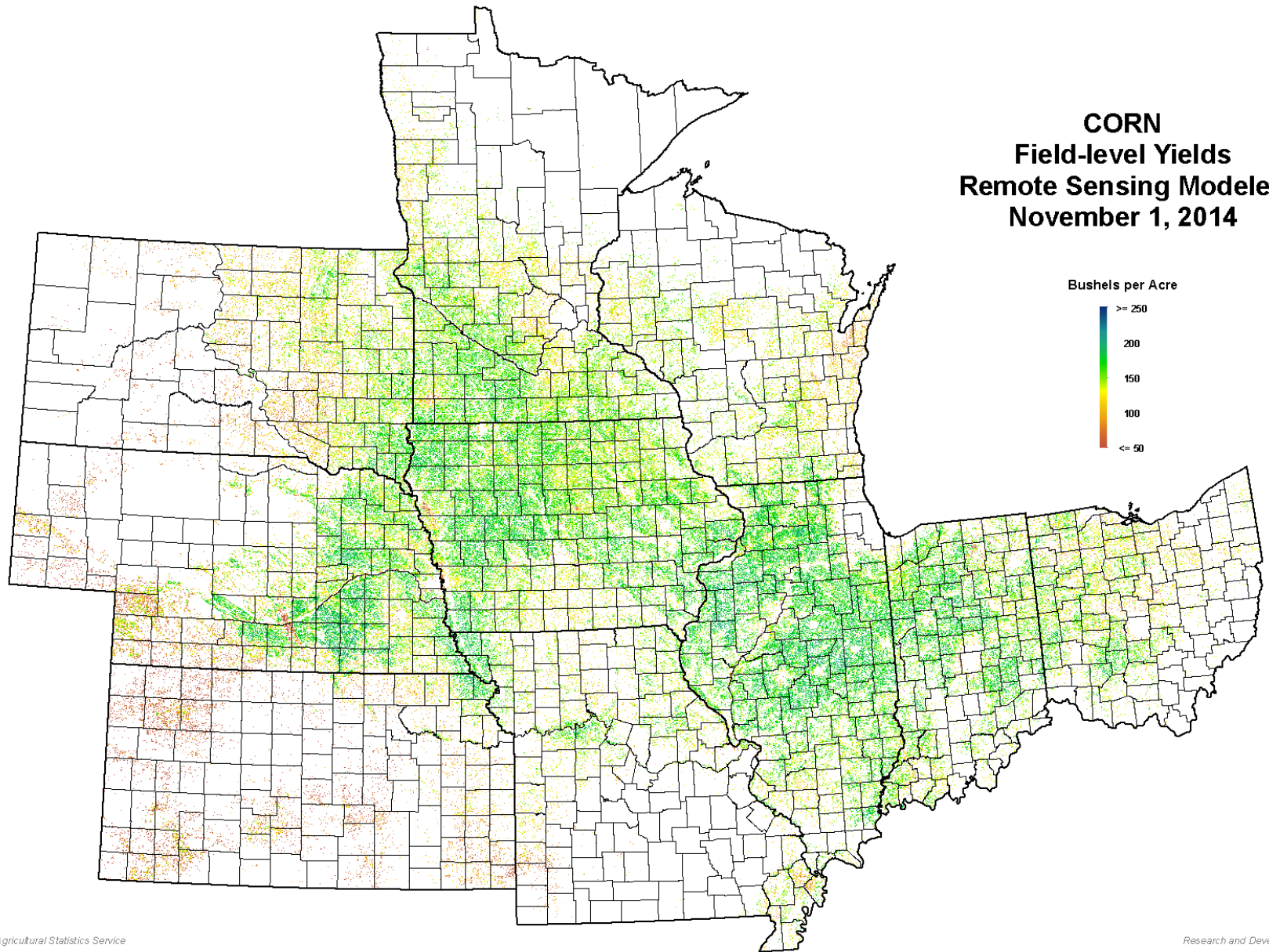


NDVI and DLST time-series correlations (r)

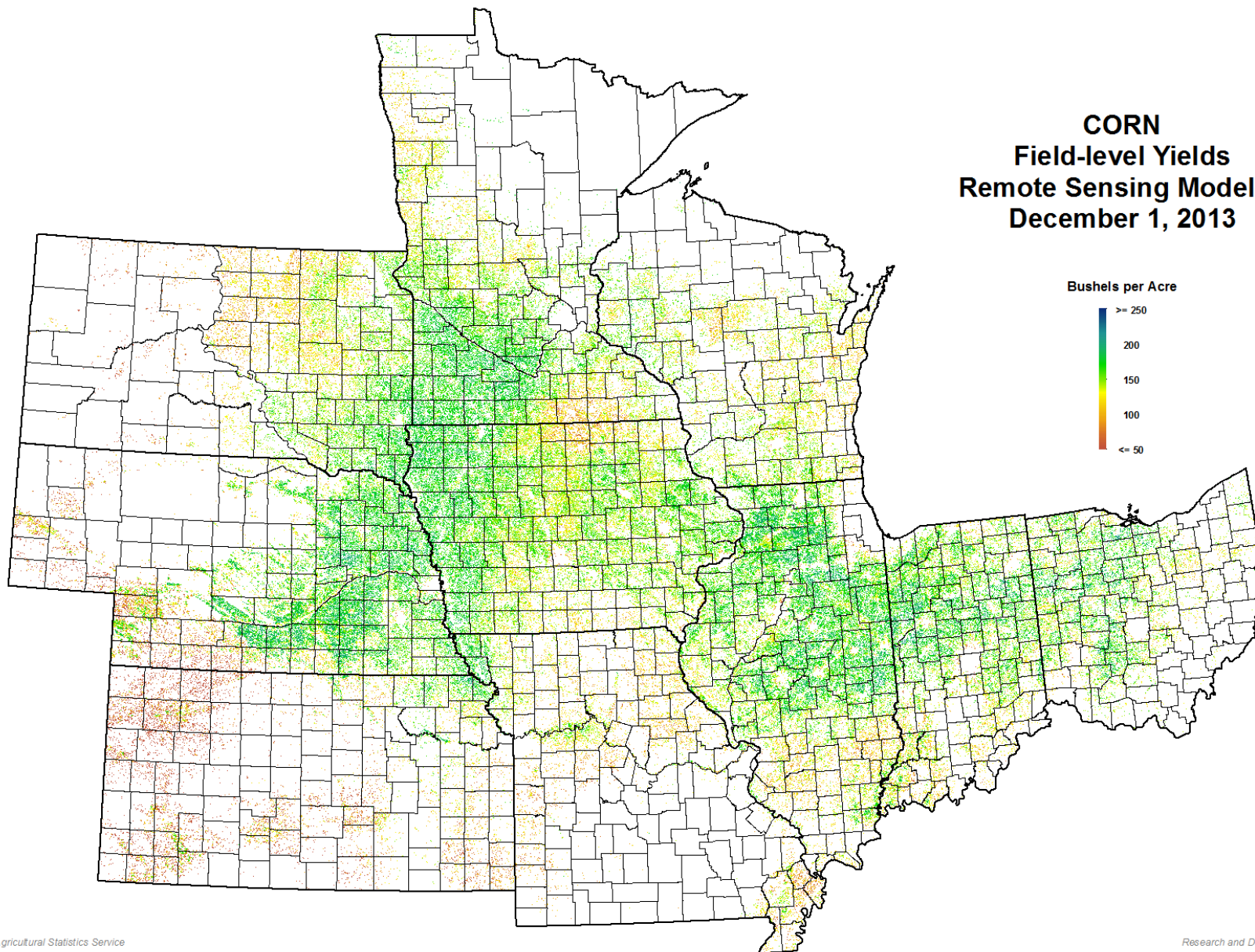
Variable vs Yield Dependence - Corn Example



CORN
Field-level Yields
Remote Sensing Modeled
November 1, 2014

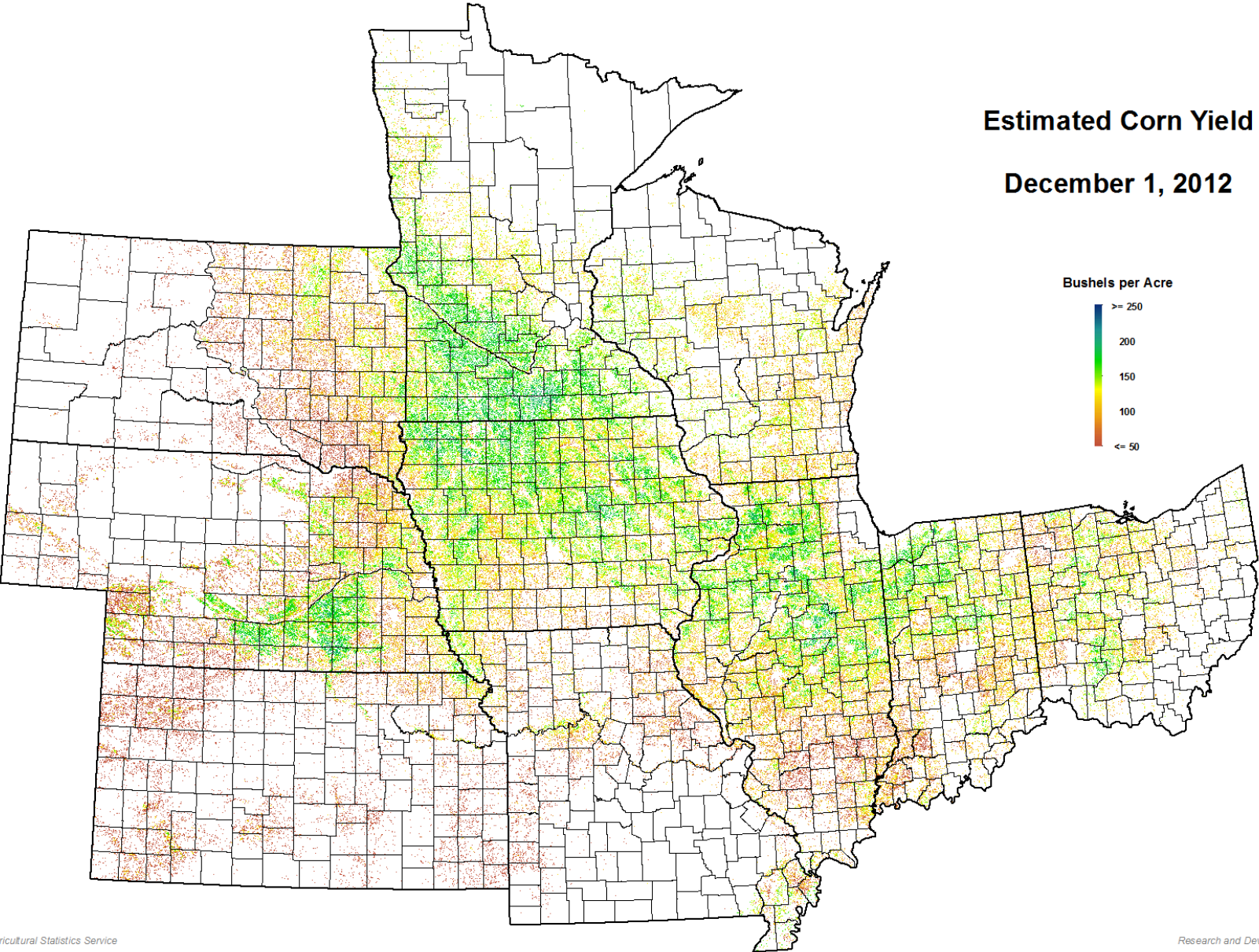


CORN Field-level Yields Remote Sensing Modeled December 1, 2013



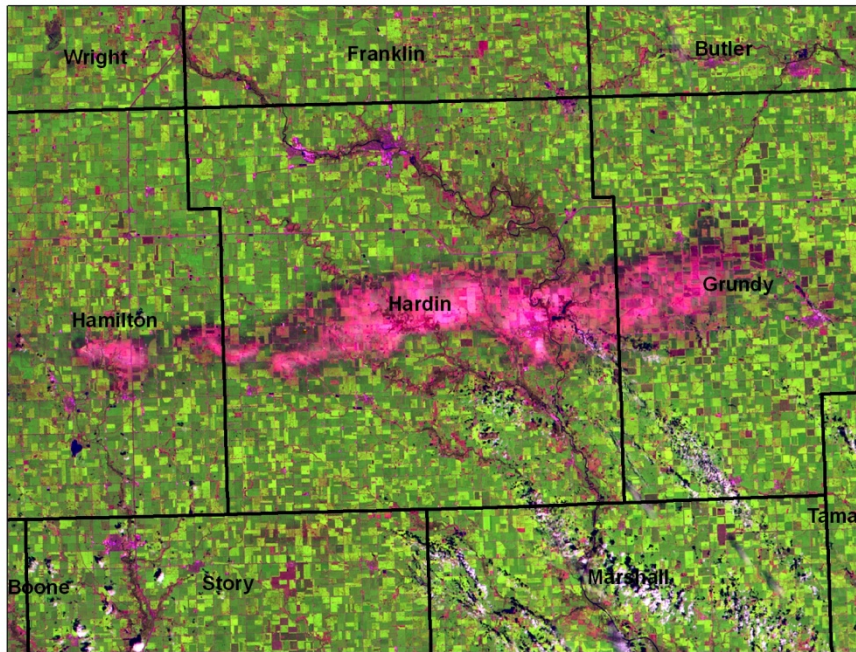
Estimated Corn Yield

December 1, 2012

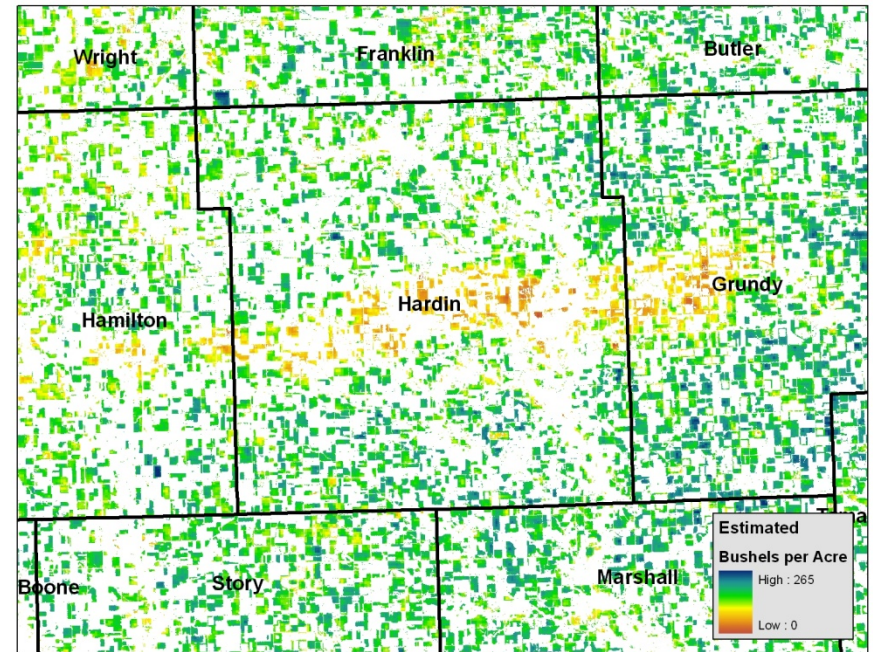


Localized example of yield map variability

Scene of a large hailstorm

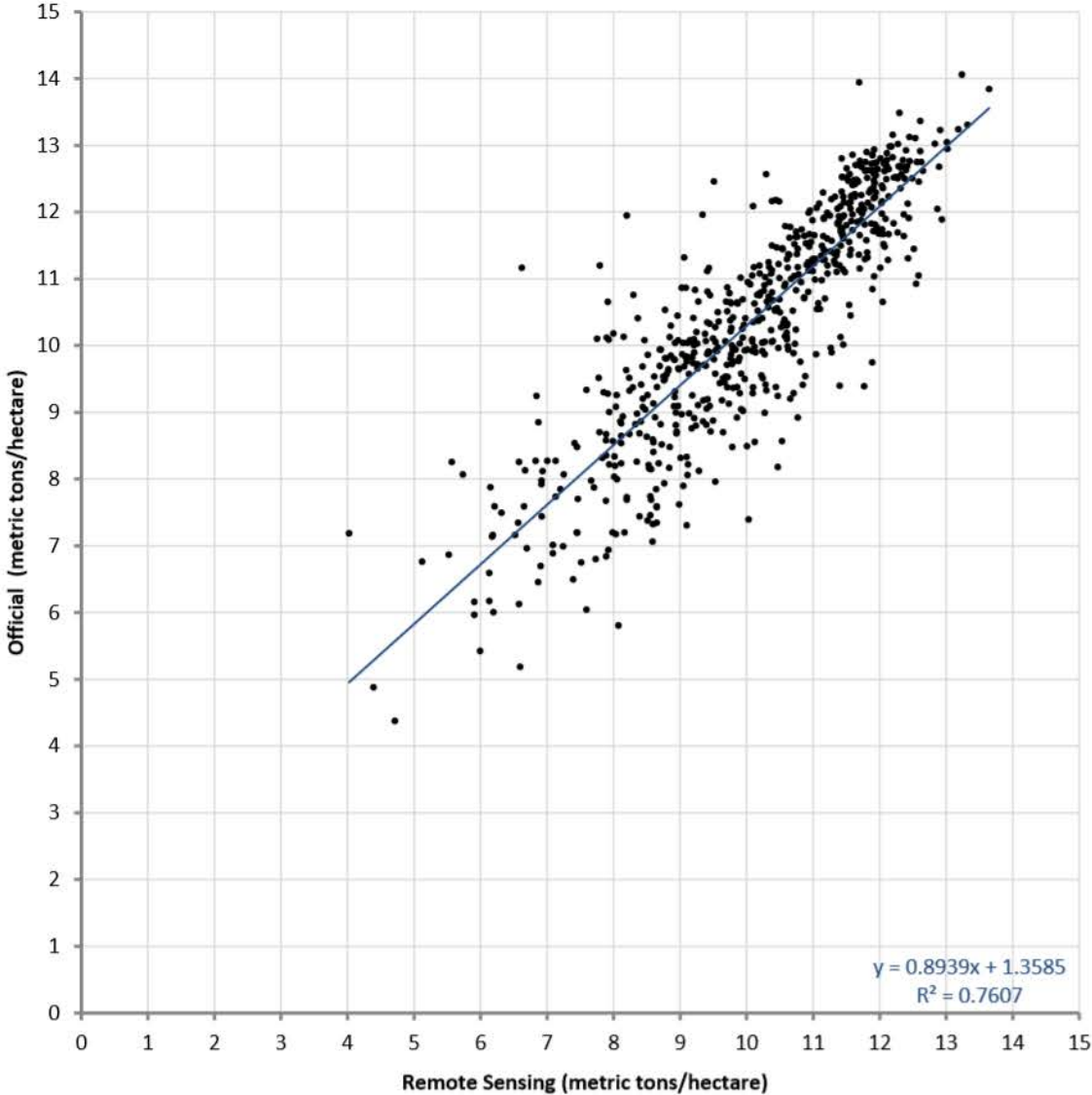


Landsat image

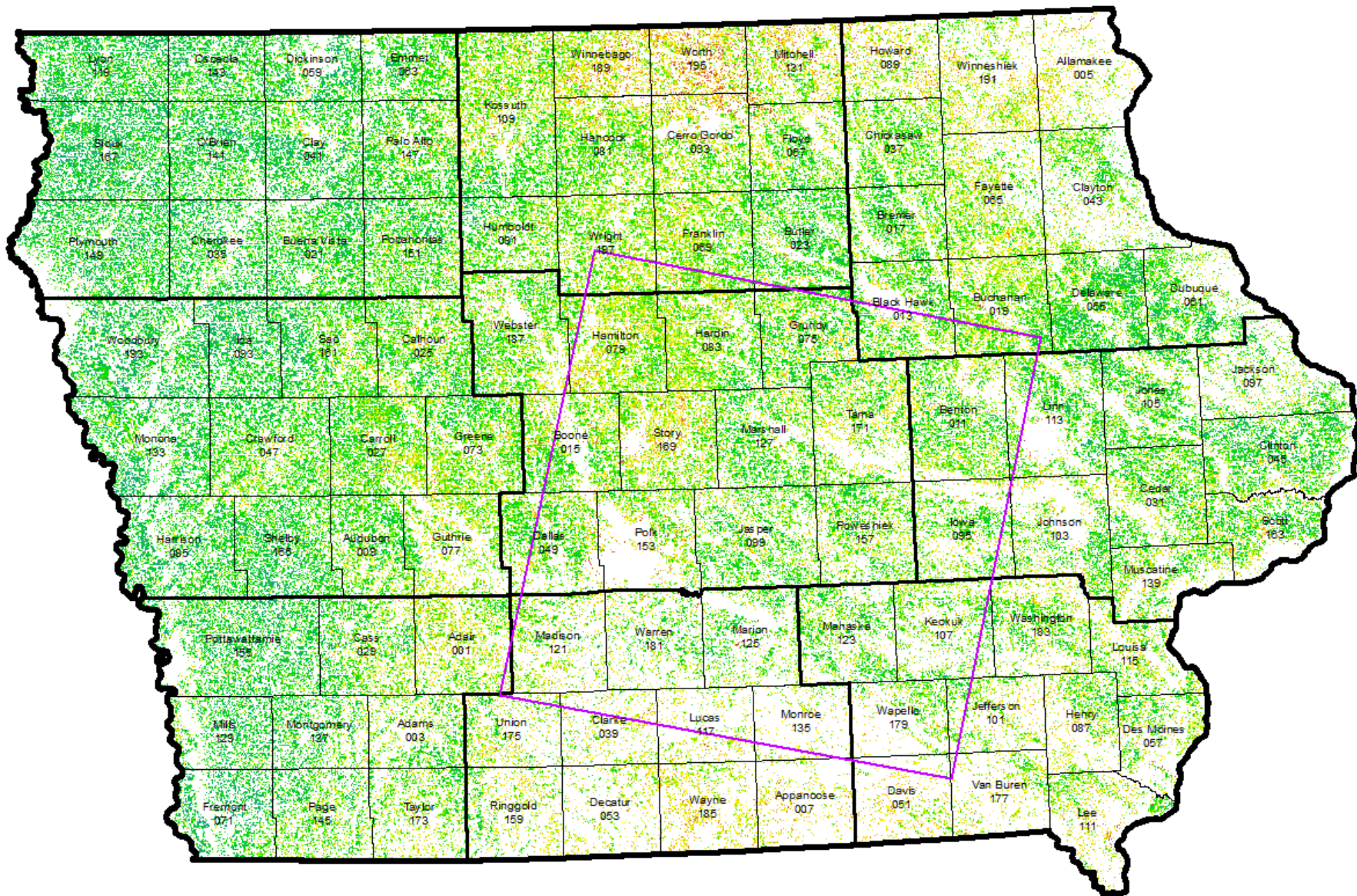


Modeled yields from MODIS

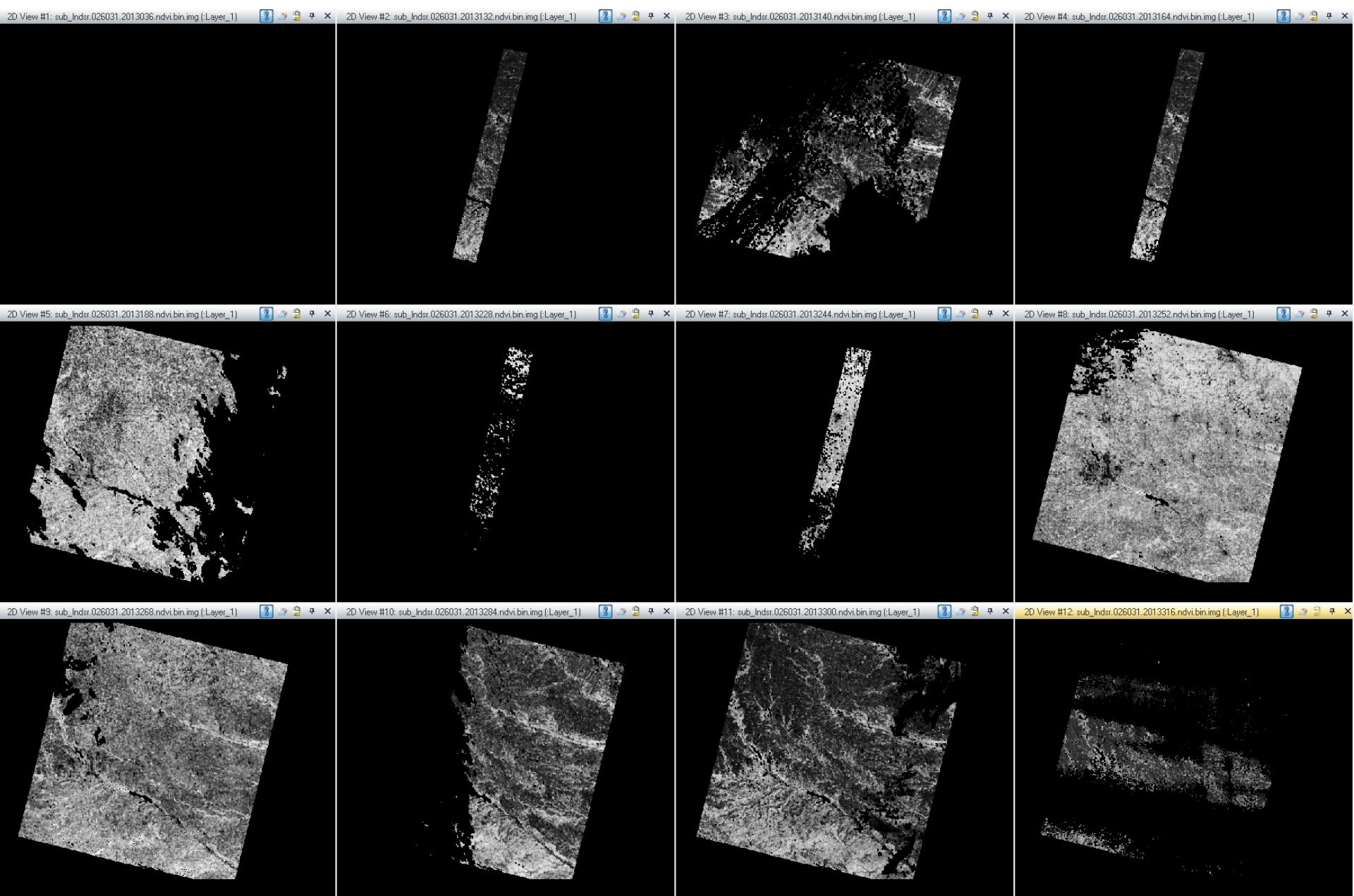
CORN
Speculative Region
County-level Yield Results
2015



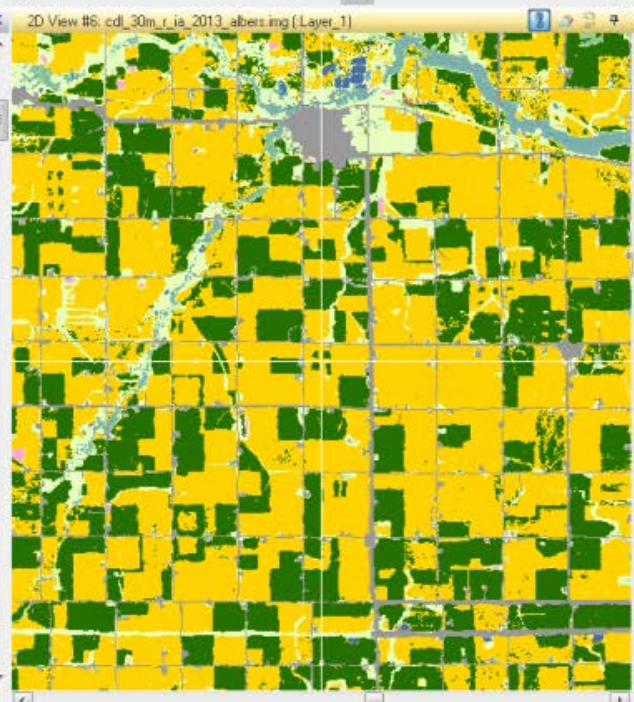
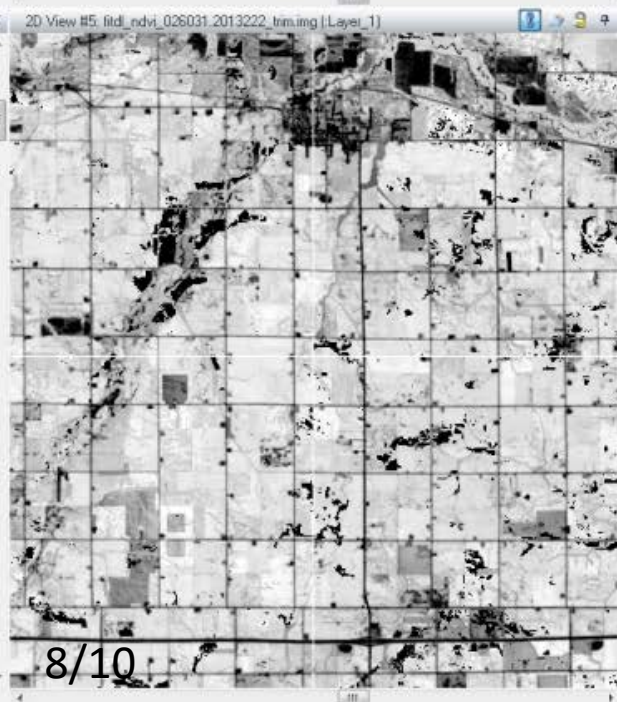
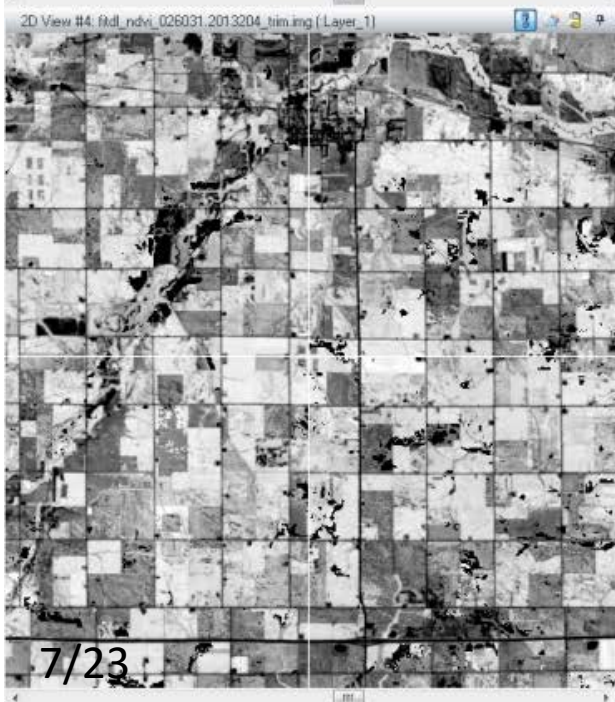
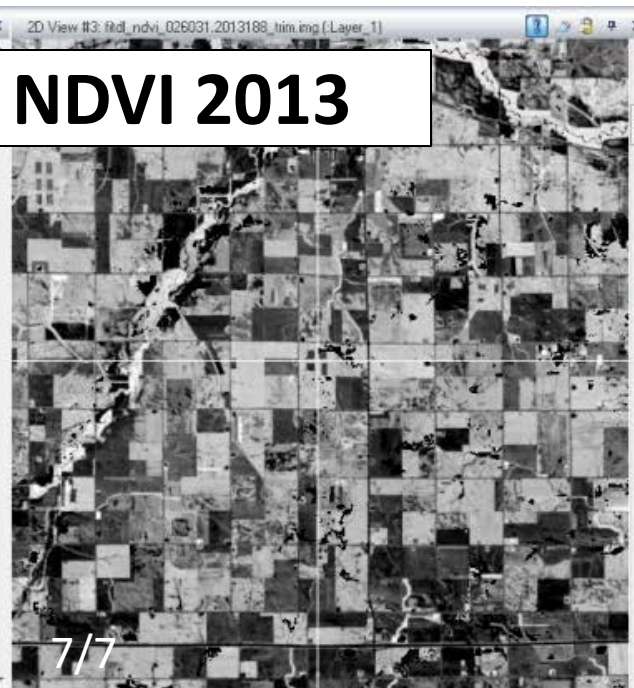
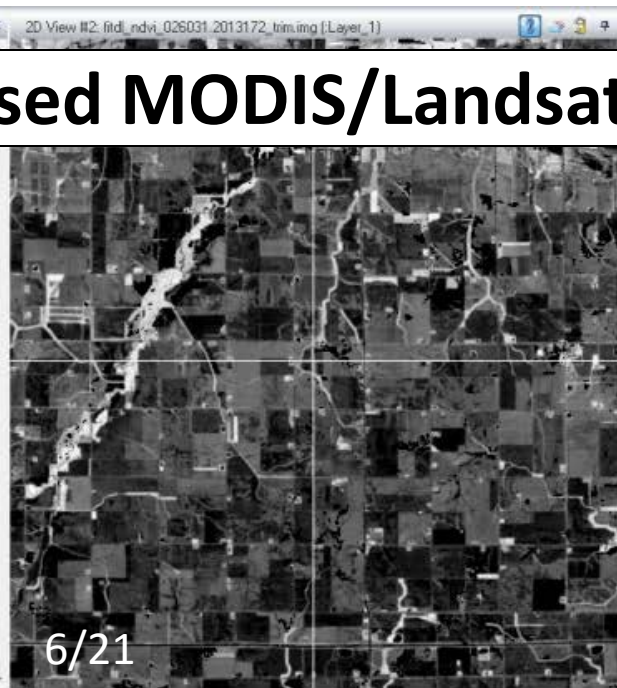
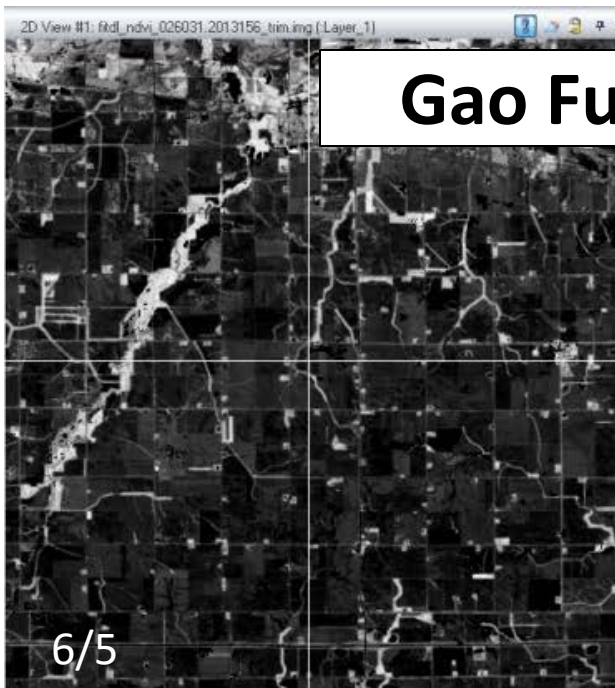
Integrating Landsat with MODIS site, p26 r31

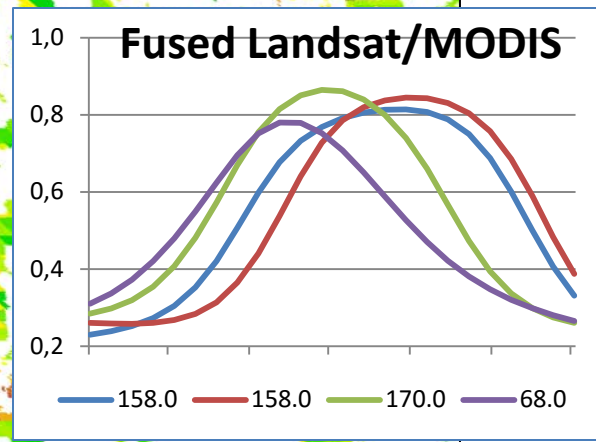
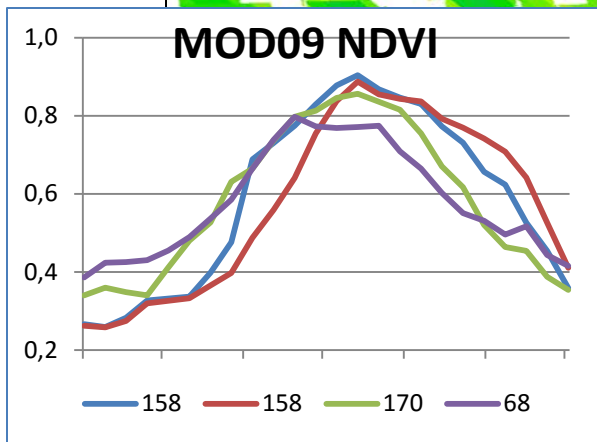
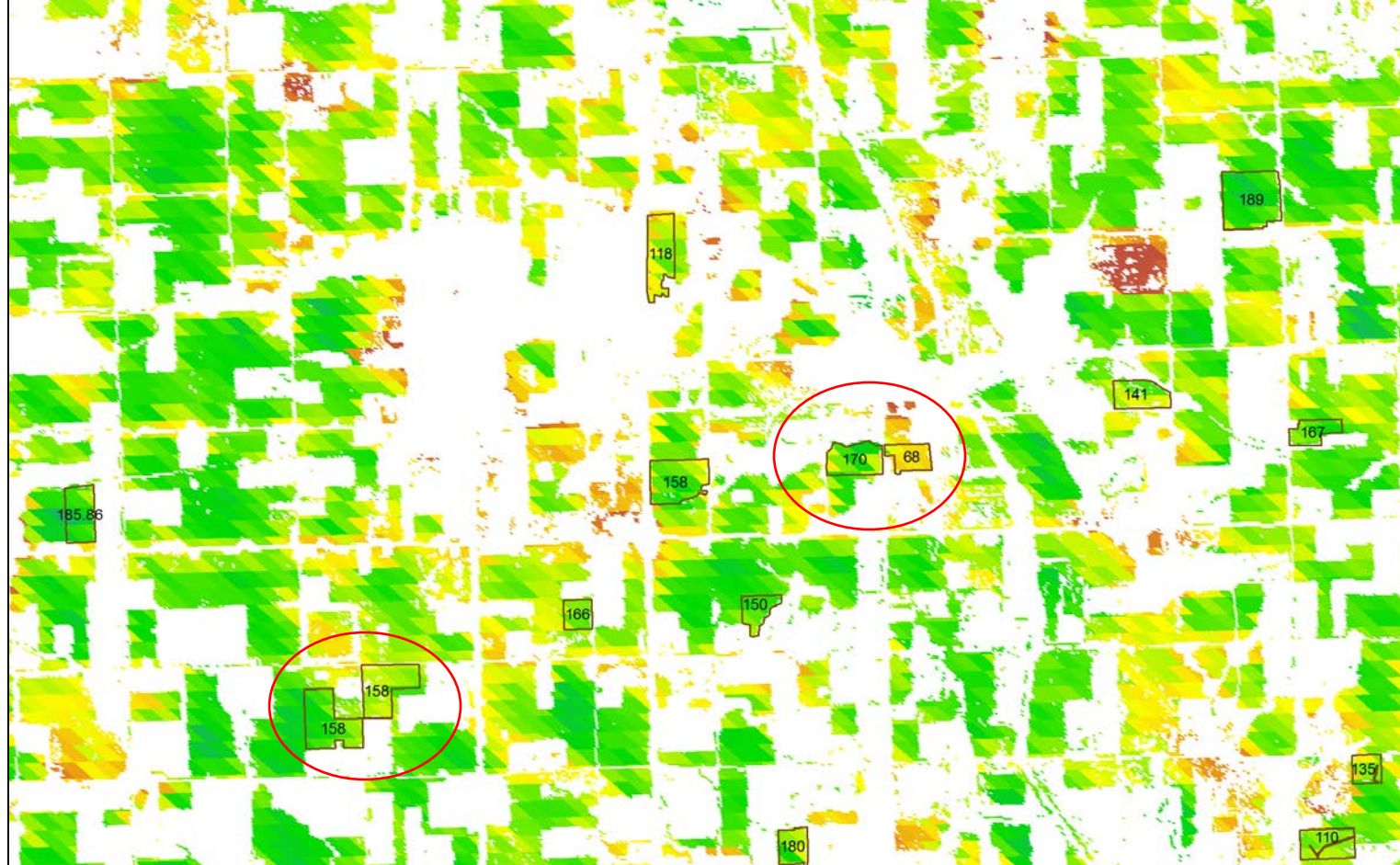


Landsat 7 and 8 p26 r31 NDVI 2013 growing season



Gao Fused MODIS/Landsat NDVI 2013





“Cloud” Computing – Google Earth Engine

The image displays two screenshots of the Google Earth Engine (GEE) web interface. The top screenshot shows a script named 'CDL_fullstate_2008and2007' being executed. The script code is as follows:

```
1 var stateFIPS = 38;  
2 var countyFIPS = 21;  
3 var stateID = 'ND';  
4 var FIPS = stateFIPS*1000 + countyFIPS;  
5  
6 var usStates = ee.FeatureCollection('ft:17aT9Ud-YnG1XdXE3UyyC');  
7 var usCounties = ee.FeatureCollection('ft:18h0kG-6N43wIW_fxAJ5');  
8 var selectState = usStates.filter(ee.Filter.eq('id', stateID));  
9 var selectCounty = usCounties.filter(ee.Filter.eq('FIPS formula', FIPS));  
10 //var region = selectState;  
11 var region = selectCounty;  
12  
13
```

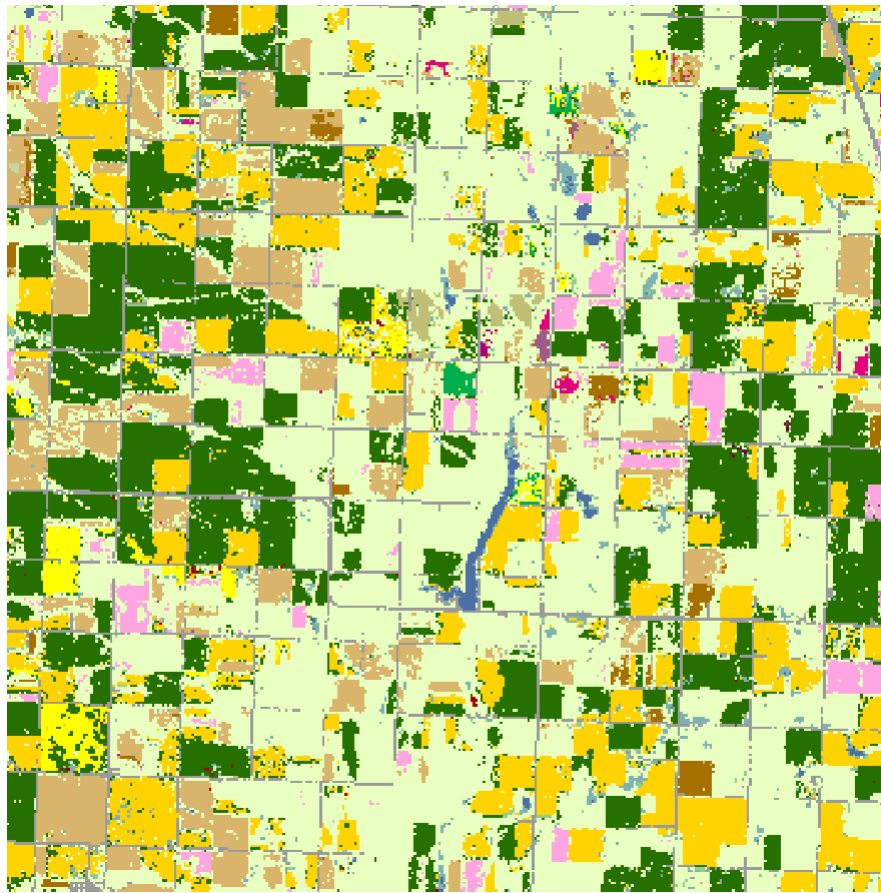
The bottom screenshot shows the same GEE interface with a different script named 'SD17' being executed. The script code is as follows:

```
1 var stateFIPS = 31;  
2 var countyFIPS = 11;  
3 //var stateID = 'MN';  
4 var FIPS = stateFIPS*1000 + countyFIPS;  
5  
6 var usStates = ee.FeatureCollection('ft:17aT9Ud-YnG1XdXE3UyyC');  
7 var usCounties = ee.FeatureCollection('ft:18h0kG-6N43wIW_fxAJ5');  
8 //var selectState = usStates.filter(ee.Filter.eq('id', stateID));  
9 var selectCounty = usCounties.filter(ee.Filter.eq('FIPS formula', FIPS));  
10 //var region = selectState;  
11 var region = selectCounty;  
12  
13
```

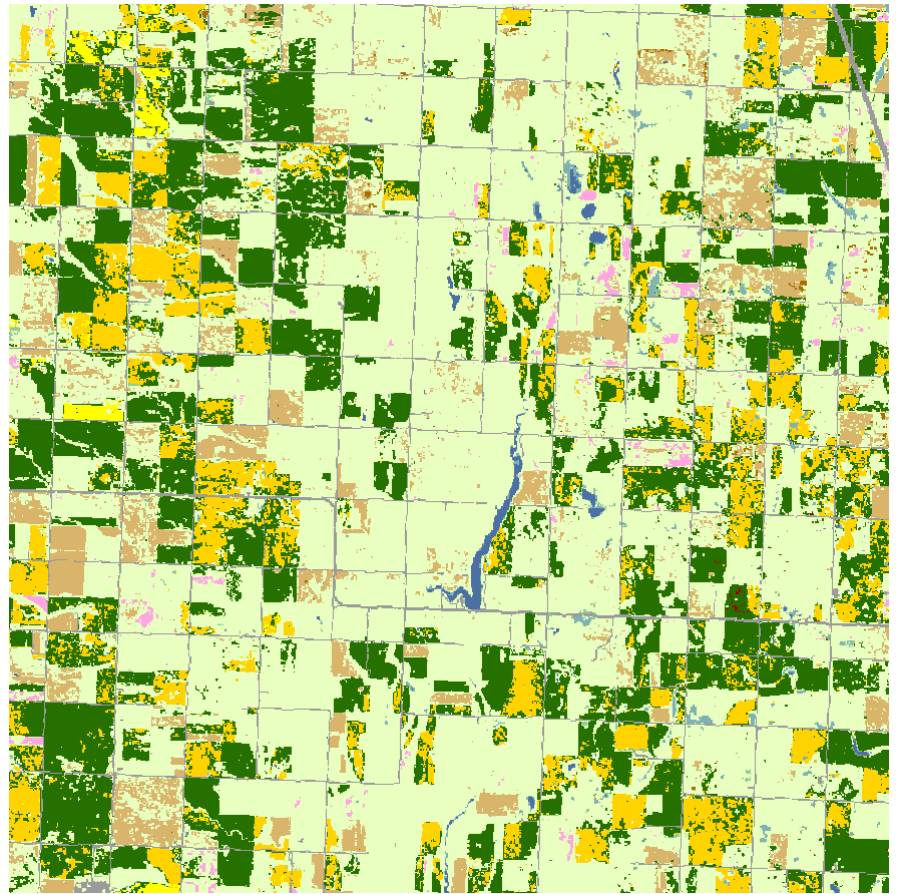
Both screenshots show a map of the United States with a red rectangular region of interest. The bottom screenshot also shows a zoomed-in view of the region, displaying a detailed map with a red rectangular region of interest. The map data is attributed to Google, with a scale of 10 km and a copyright notice for 2016.

The whole Landsat and MODIS archive staged in GEE for analysis

GEE: Use to produce future and retrospect CDLs?



2008 CDL

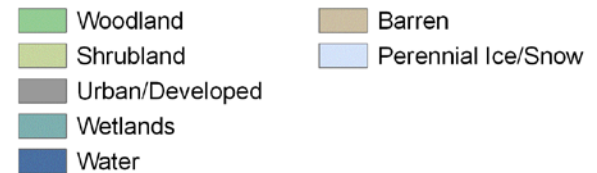


2007 (non existent currently)

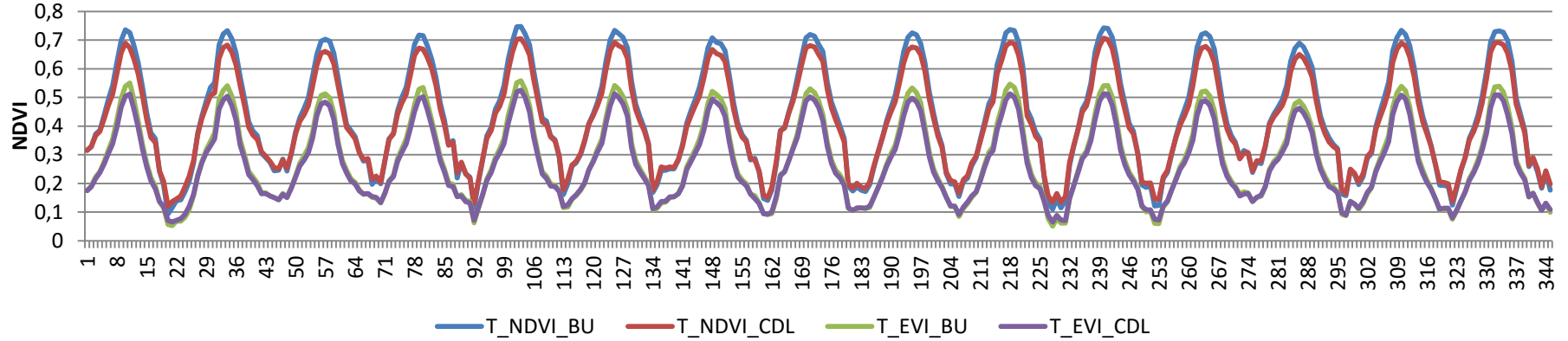
Agriculture



Non-Agriculture

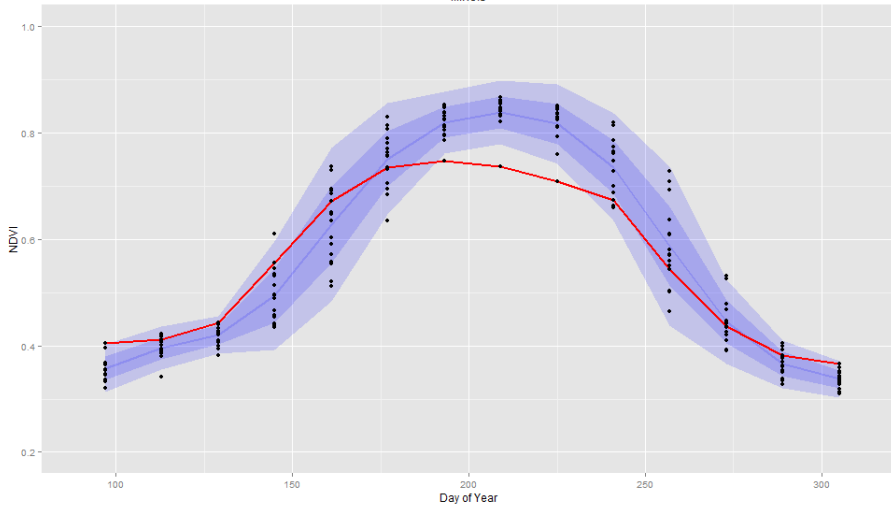


GEE time series analysis



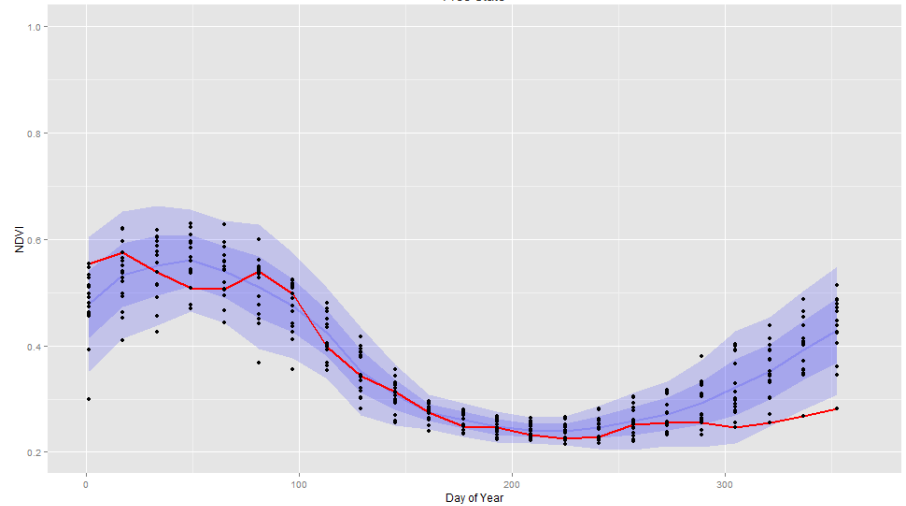
T_NDVI_BU T_NDVI_CDL T_EVI_BU T_EVI_CDL

Illinois



Illinois, USA crop areas

Free State



Free State, South Africa crop areas



Thanks



David M. Johnson
Geographer

United States Department of Agriculture
National Agricultural Statistics Service

