Where Do the Crop Statistics Come From? It's More Than You Think

Integrating Remote Sensing-based Products Into the USDA/NASS Operational Estimating Programs

Larry W. Beard
Senior Agricultural Statistician
NASS/RDD/Geospatial Information Branch; Fairfax, VA
For the 2011 Indiana Certified Crop Advisor Conference

Presentation Overview

- Intro & Background
- Overview of *NASS Surveys*
- Review *NASS Remote Sensing Programs*
- Focus on *Crop Progress & the Future*
- Questions

Locked Up!!


NASS
Agriculture Counts
Secure Area
Authorized
Personnel Only
THIS AREA WILL BE
LOCKED
8:30 A.M.
Required Personnel Only
Call 720-4334 For Information

History

George Washington

How's the corn lookin'?

Journal and Courier

A Gannett Newspaper Lafayette-West Lafayette, Indiana, Monday August 6, 1979 Vol. No. 60—No. 218 ★ 20 Cents

5 area counties 'pose' for Landsat

By TOM CAMPBELL
Staff Farm Writer

Ever wonder what the town of Otterbein looks like from space? Or U.S. 52? Or a 200-acre field of corn?

Photographic printouts from two Landsat satellites now circling the Earth can show you that from a height of 567 statute miles Otterbein is about one inch across. The houses look like freckles on a child standing about a foot away. Just to the left of Otterbein is U.S. 52, which looks like a long slash from a Flair pen. And a 200-acre corn field looks like a piece of Corn Chex cereal that has fallen to the kitchen floor.

Might sound like pretty trivial information at first, but that information, it is hoped, will enable agricultural experts to predict annual crop production figures in the United States to within a percentage point of accuracy.

"We're still in the experimental stages with this project," said Larry Beard of the United States Department of Agriculture, who is stationed at Purdue University. Beard works for the statistics branch of the Economics, Statistics and Cooperatives Service.

"We're about six years away from reaching our potential. First of all, we have to prove if it is effective and accurate."

Although the Landsat satellite has been orbiting the Earth every 18 days since 1972, only now are experts learning how to fully apply the information sent back to the National Aeronautics and Space Administration in Houston, Texas.

Once every 18 days, as Landsat passes over the United States, it records information from 202 segments of land in 29 states, including nine segments in Indiana, and five in the Journal and Courier circulation area — in Tippecanoe, Montgomery, Warren, Benton and Newton counties.

All of the Indiana segments are in the upper half of the state, in the prime corn and bean growing areas.

"We hope to have the technology in a few years to be able to get readouts on fields as small as five acres," said Beard, "but right now we are limited to 40-acre fields as a minimum, because we just don't have the technology. Only the CIA has that kind of technology available right now," Beard added.

By using infra-red photography, the Landsat will try to determine crop yields for the first time this fall. It has been programmed to "read" barley, rice, cotton, sorghum, wheat, beans and corn crops.

The satellite picks up different amounts of electromagnetic energy which is reflected, scattered or emitted by not only the crops, but by varying soil contents, trees, water or whatever other object might be occupying ground space.

Then when a computer takes information relayed from Landsat, it can translate the information into recognizable printouts that will tell experts like Beard what each plot of land contains.

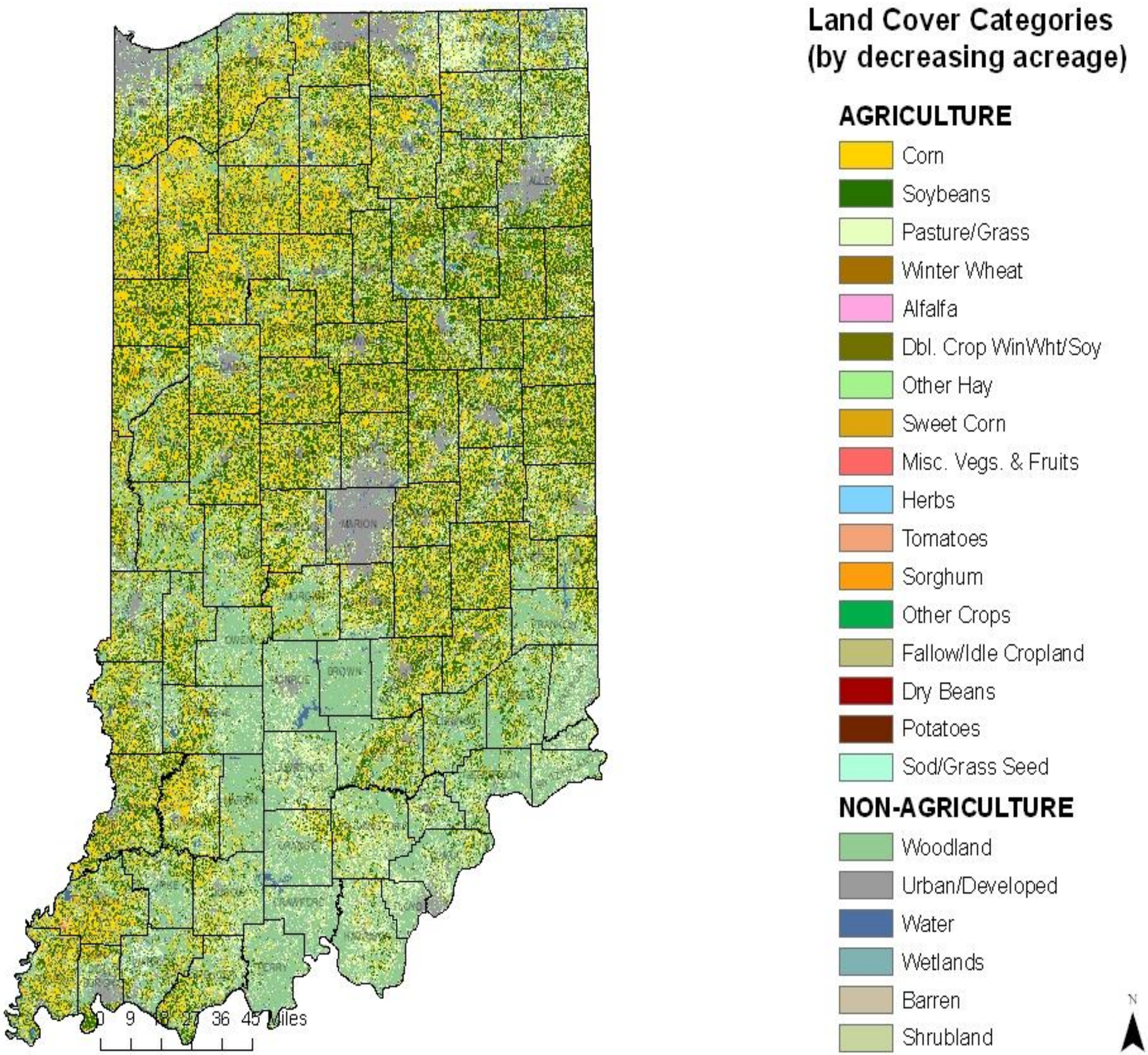
Similar aerial surveys have been taken with a helicopter and airplanes, but Beard says those surveys are not as economically feasible as from the satellite, which can take a photograph of a 30-square-mile area.

"Planes don't give a large enough estimate," Beard said. "You can't make a survey in every county in the country — it would be too expensive. We're talking aobut a national estimate."

Outside of the original expense of building, launching and monitoring the satellite, the

See LANDSAT, Page A-2

2010 Indiana Cropland Data Layer

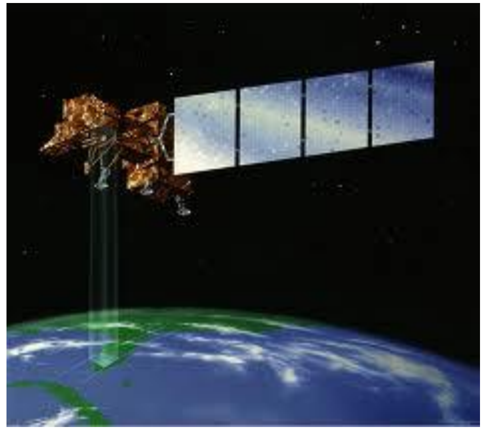


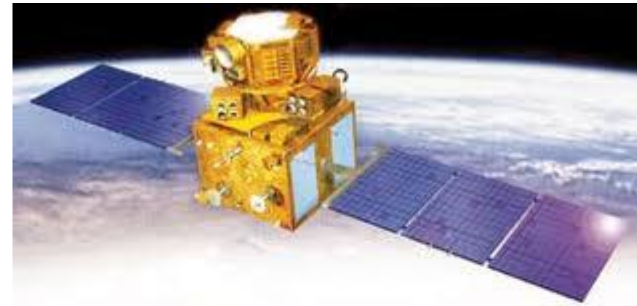
NASS ♥ Surveys!!!
And Data

ACREAGE	YIELD	PROGRESS & CONDITION	BALANCE SHEET End of Marketing Year
QRTRLY AG SURVEYS • Farm Operators • March – Intentions • June – All Crops • Sept.– Small Grains • Dec.- Row Crops, WW • 75-84,000 US Samples • ~2600 Indiana	AG YIELD SURVEYS • Farm Operator Survey • Sample ~ 29,000 U.S. • Sample ~ 670 Indiana • Monthly Aug-Nov. • First of Month • Data Improves Monthly	CROP WEATHER • Ext. Agents, FSA • Weekly • May – November • Subjective, opinion survey • ~ One report per county • State Averages weighted by County	SUPPLY (-) DEMAND • Exports (FAS) • Processed (Commerce, Factory) • Farm Use (seed, feed, etc.) • Imports (Customs, AMS) • Ending Stocks (NASS) • Residual
JUNE AREA SURVEY • 11,000 "Segments" • ~640 Acres in Size • Personal Enumeration of ~ 35,000 Tract Operators • Early June	OBJECTIVE YIELD • Field Plots, plant counts & measurements • Corn 1,920 US Samples • 170 for Indiana • Soybeans 1,835 US • 180 in Indiana		
FSA • Program Acres Planted • Database almost complete by October	DEC. AG SURVEY • Large Producer Survey • Sample ~83,000 U.S. •Sample ~ 2,600 for IN. • Primary survey for Late Season Crop Yields		(** Also Industry & Factory data, 5 year Ag Census, and County Estimates)

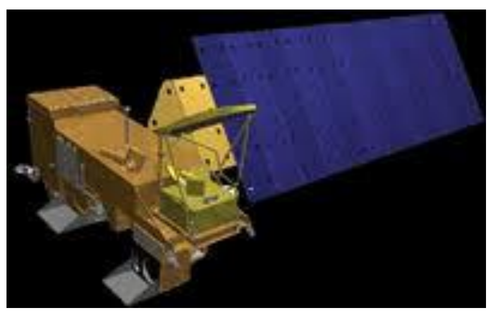
We ♥ satellites!!!


Landsat 5


Landsat 7


ResourceSat 1


Terra


Aqua

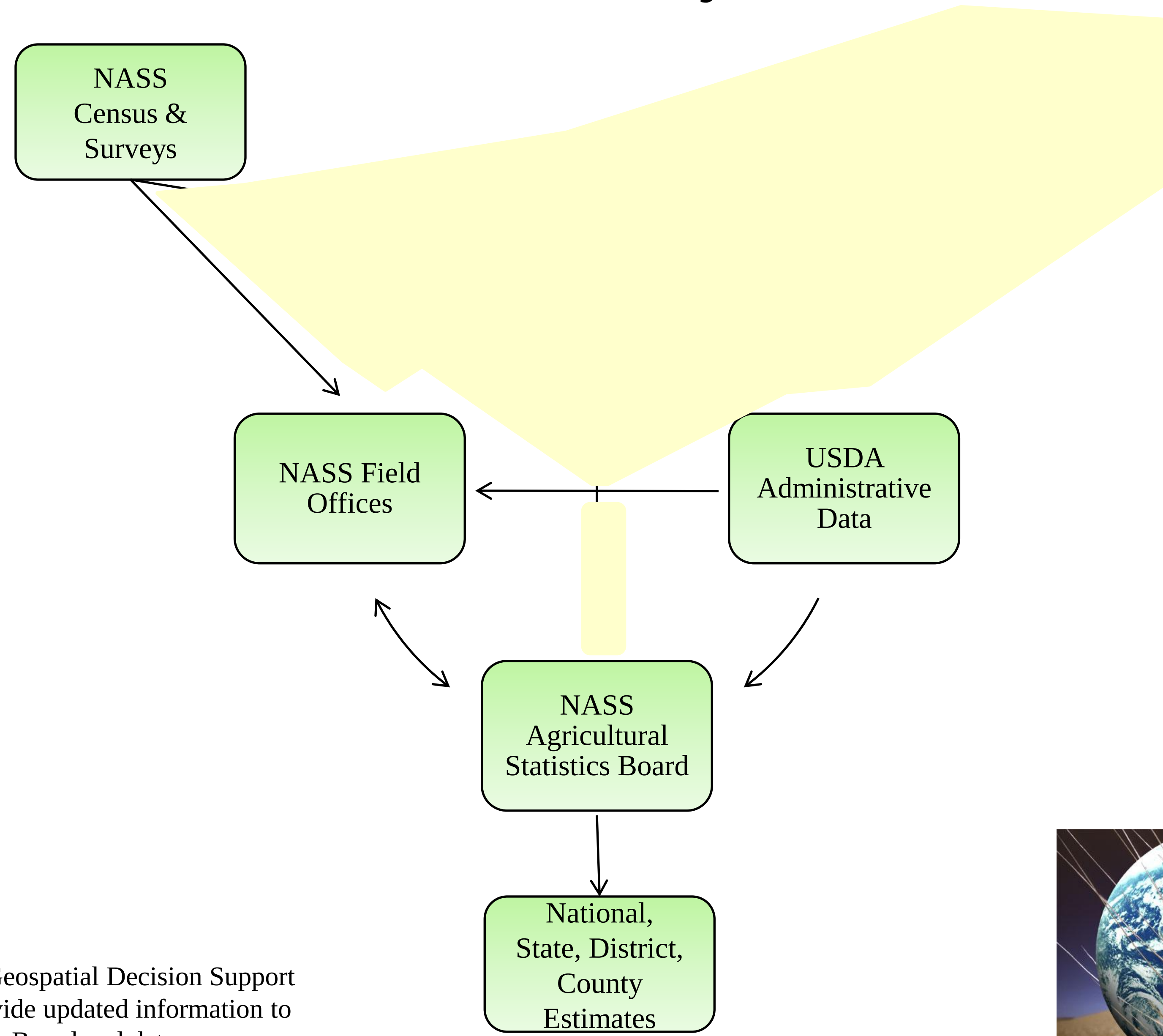

Deimos


UK-DMC-2

Approx. 3,000 satellites orbiting the earth at any given time.

Satellite sensors see things differently

NASS Estimation Systems



* NASS Uses Geospatial Decision Support Systems to provide updated information to the Ag Statistics Board and data users

2011 Production Plans

USDA

January

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

February

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28					

March

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

April

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Acreage Report – Winter Wheat

Crop Production Report – Corn & Soybeans

May

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

June

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

July

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

August

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Crop Production Report – CDL Cotton, Rice, & Peanuts

County Estimates - All Crops

September

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

October

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

November

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

December

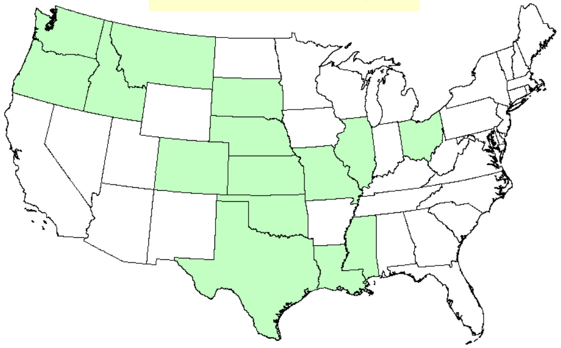
Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Small Grains Summary

Crop Production Report – All Crops

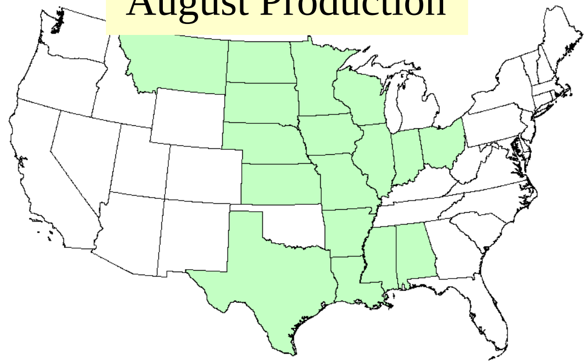
CDL 2011
in-season production
@ 30m

June Acreage



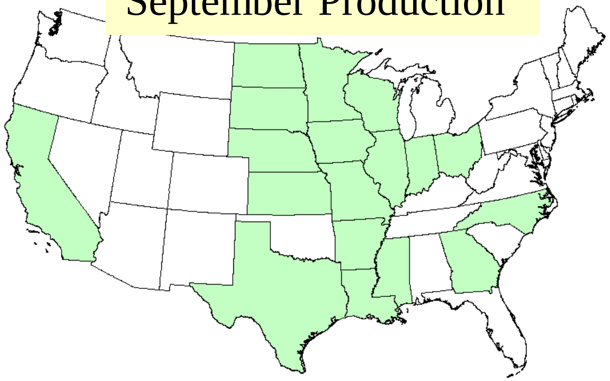
15 States – winter wheat

August Production



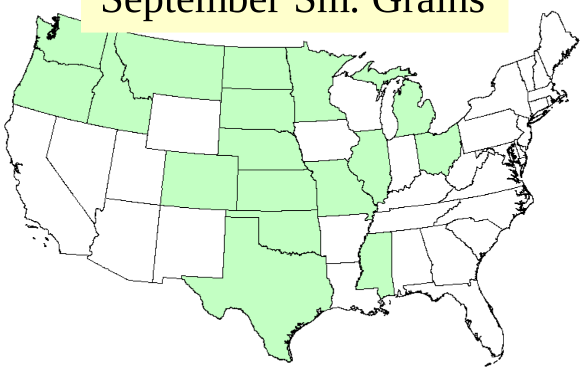
17 – Corn & soybeans +

September Production



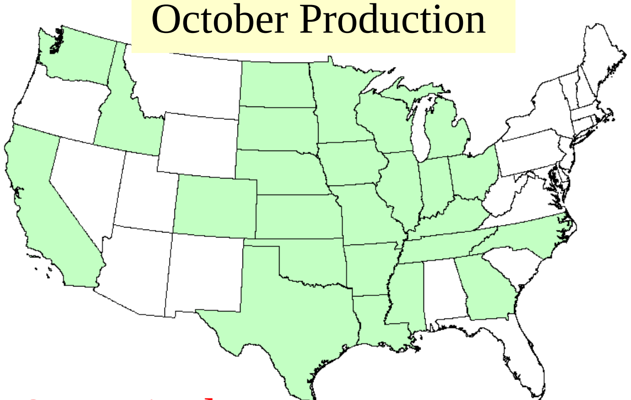
18 – Rice, cotton & peanuts +

September Sm. Grains



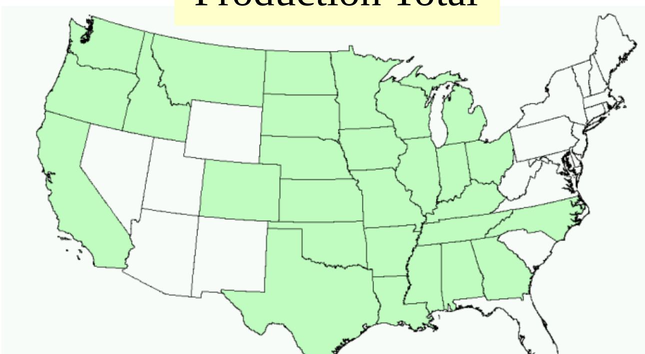
17 – Final Small grains

October Production

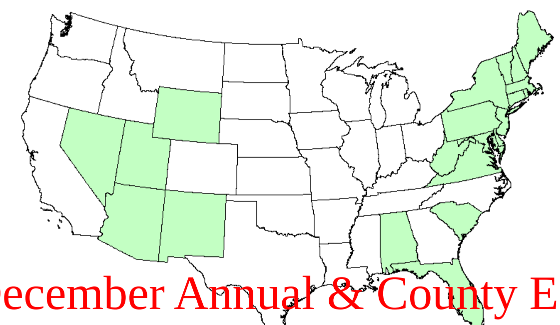


25 – Final Late-season crops

Production Total



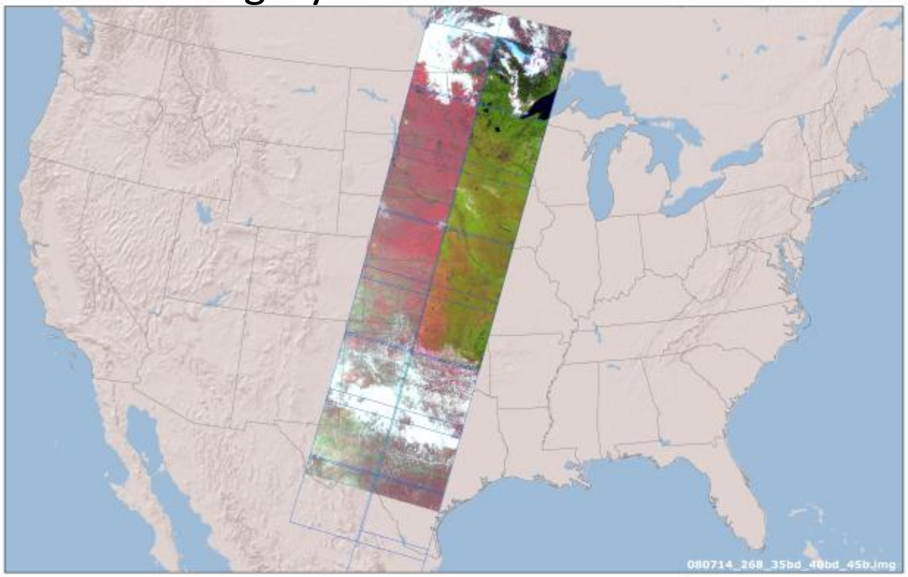
28 – Total In-season operational



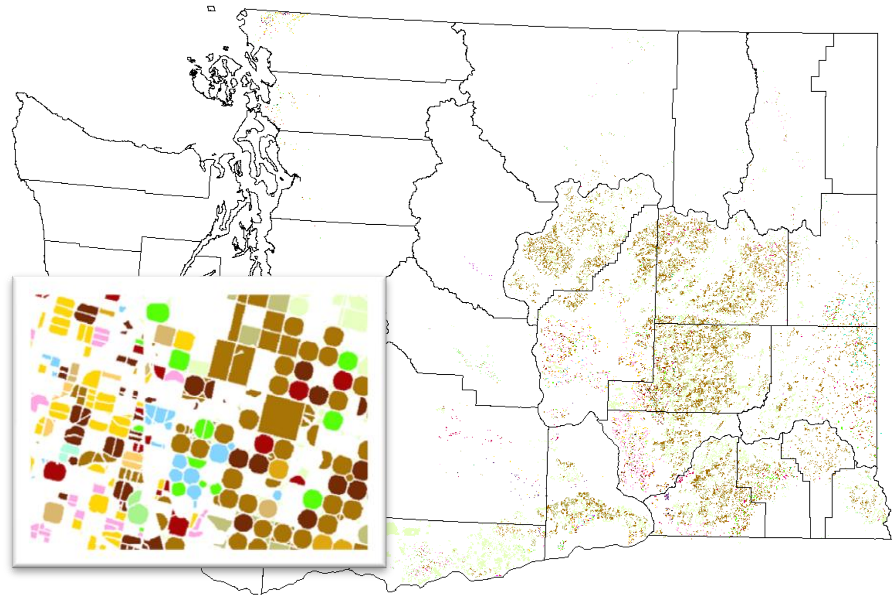
December Annual & County Estimates

2011 Cropland Data Layer Inputs

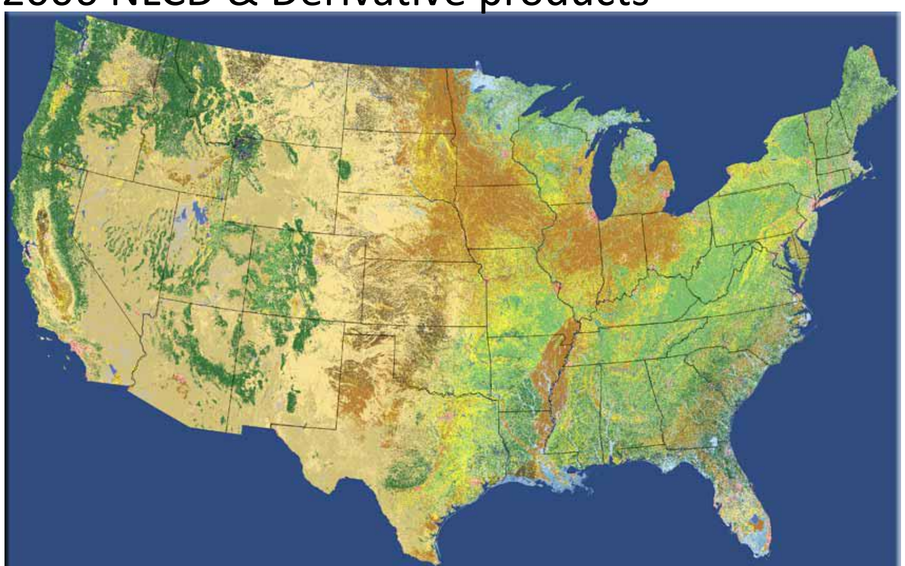
Satellite Imagery – DMC & Landsat



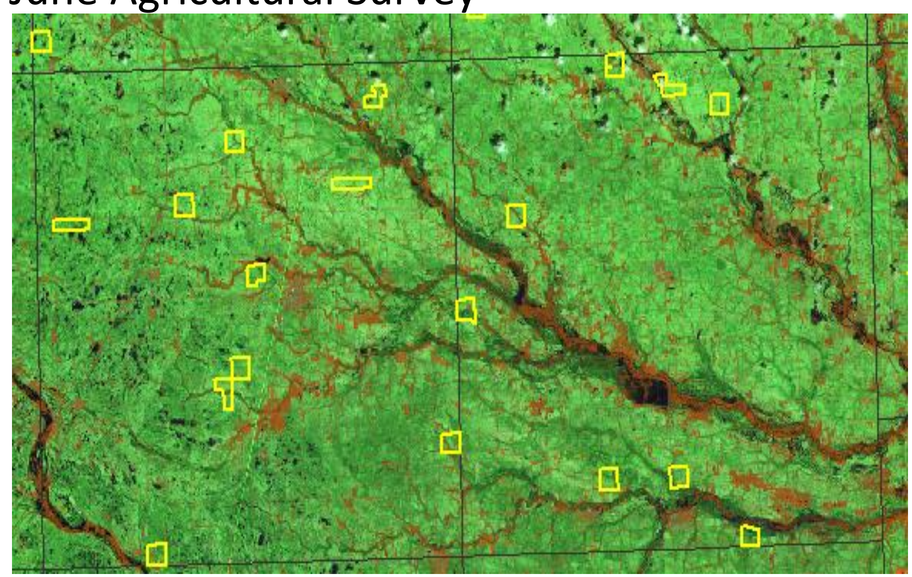
Farm Service Agency: Common Land Unit

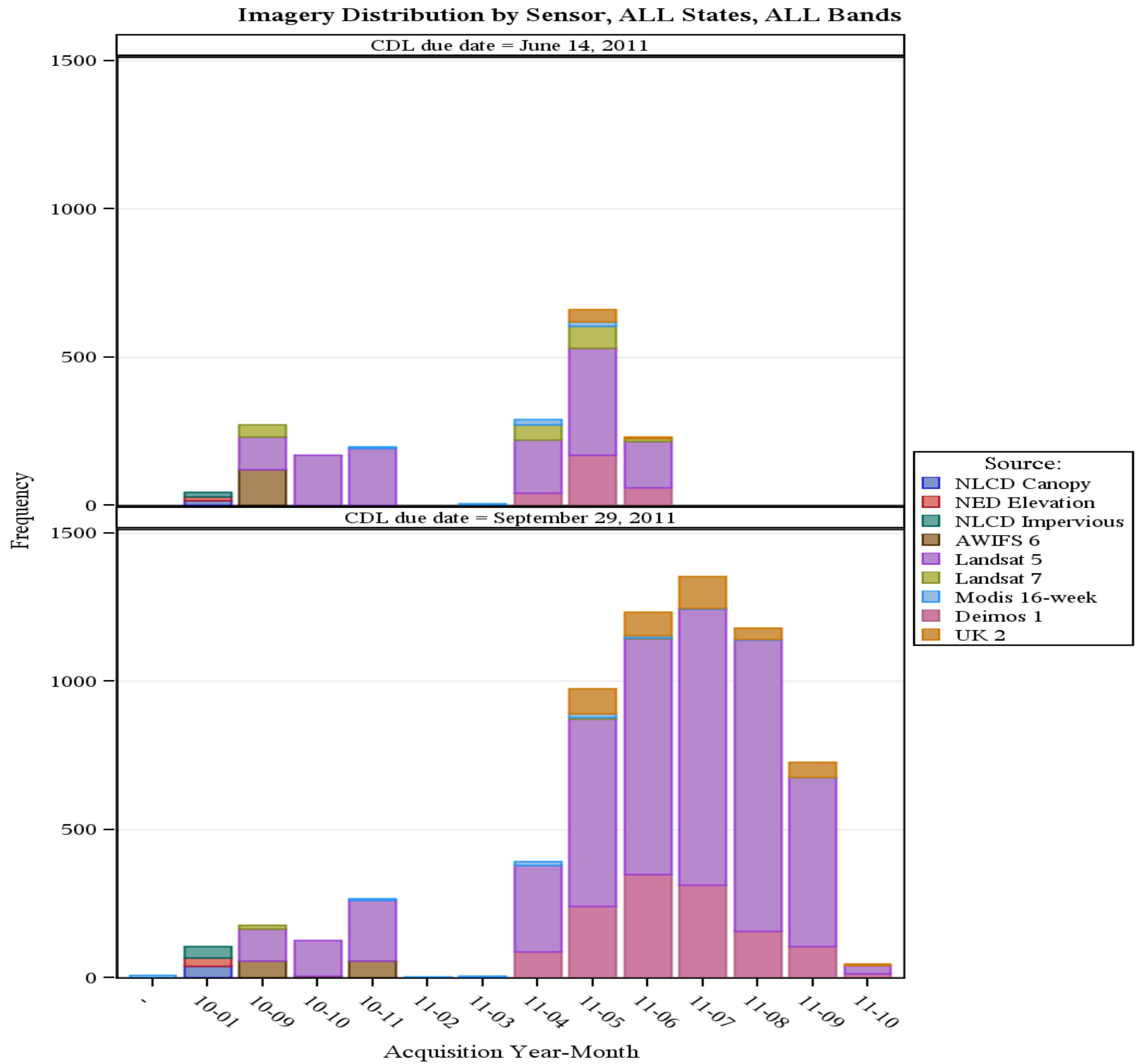


2006 NLCD & Derivative products



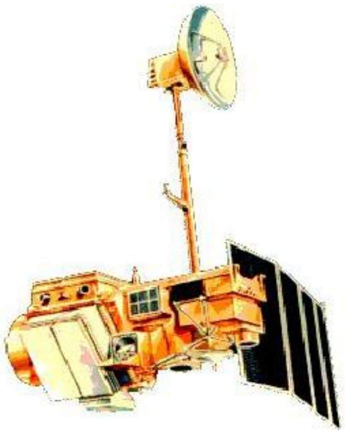
June Agricultural Survey





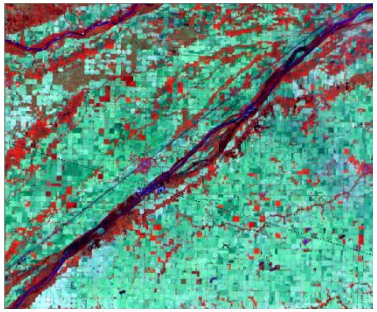
Imagery Distribution by Sensor, ALL States, ALL Bands
CDL due date = June 14, 2011
CDL due date = September 29, 2011
1500
1000
500
0
Frequency
-
10-01
10-09
10-10
10-11
11-02
11-03
11-04
11-05
11-06
11-07
11-08
11-09
11-10
Acquisition Year-Month
Source:
NLCD Canopy
NED Elevation
NLCD Impervious
AWIFS 6
Landsat 5
Landsat 7
Modis 16-week
Deimos 1
UK 2

Side-by-Side Comparison

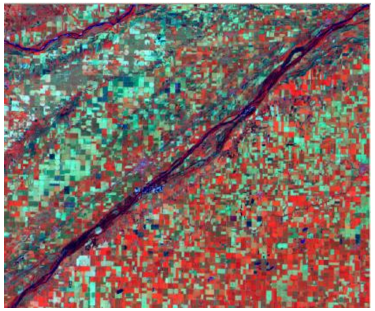


	Deimos/UK2	Landsat 5
Launch Date	2009	1984
Resolution	22 meters	30 meters
Spectral Bands	B2: 0.52 – 0.60 B3: 0.63 – 0.69 B4: 0.77 – 0.90 (Green, Red, NIR) 3 bands total	B2: 0.52 – 0.60 B3: 0.63 – 0.69 B4: 0.75 – 0.90 B5: 1.55 – 1.75 (Green, Red, NIR, SWIR) 7 bands total
Swath Width	600 kilometers	185 kilometers
Revisit Rate	4 Days	16 Days

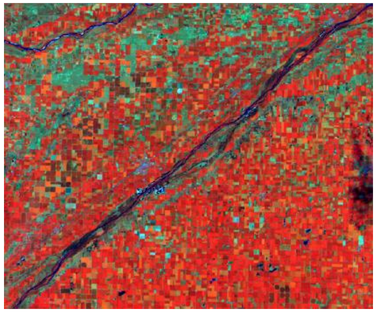
Imagery Time Series



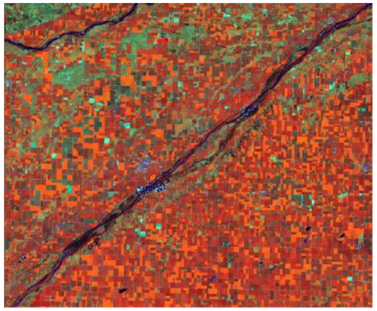
May 18



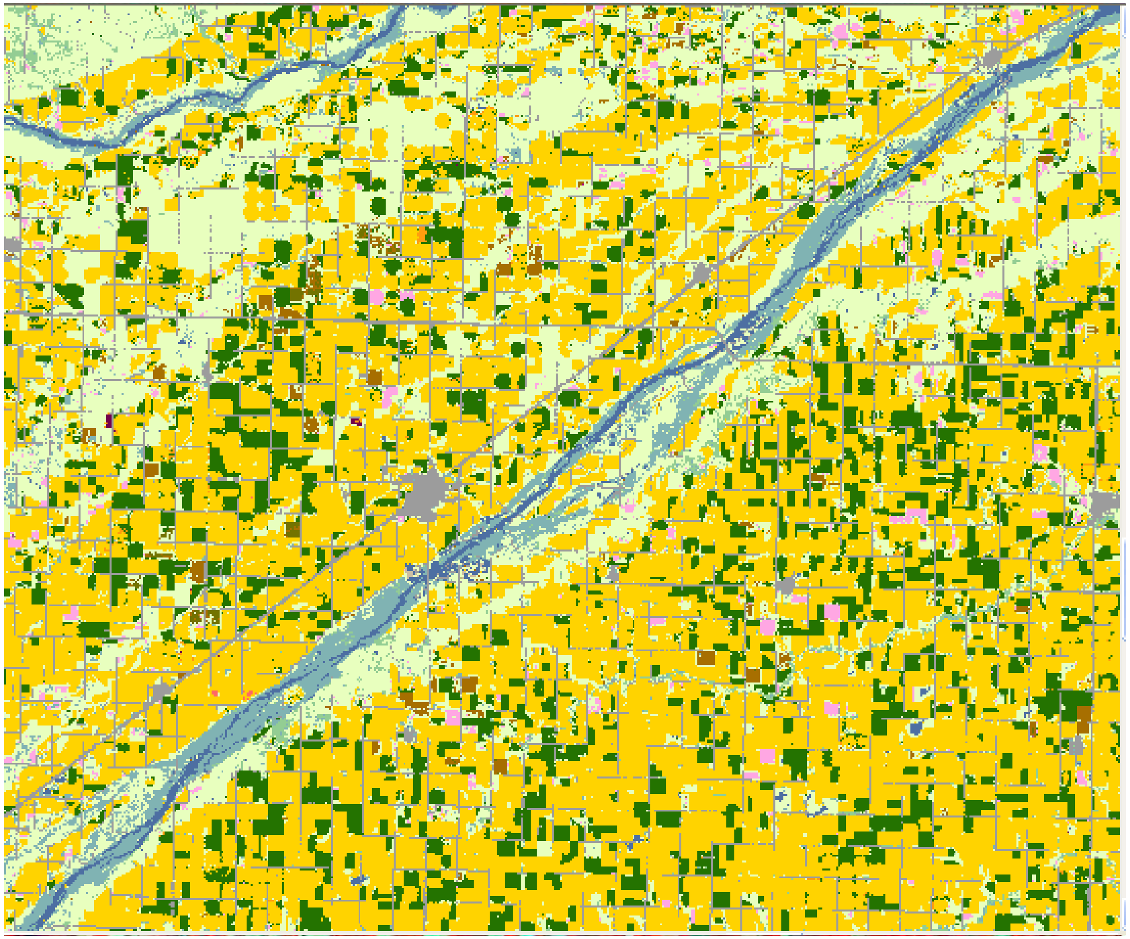
June 21



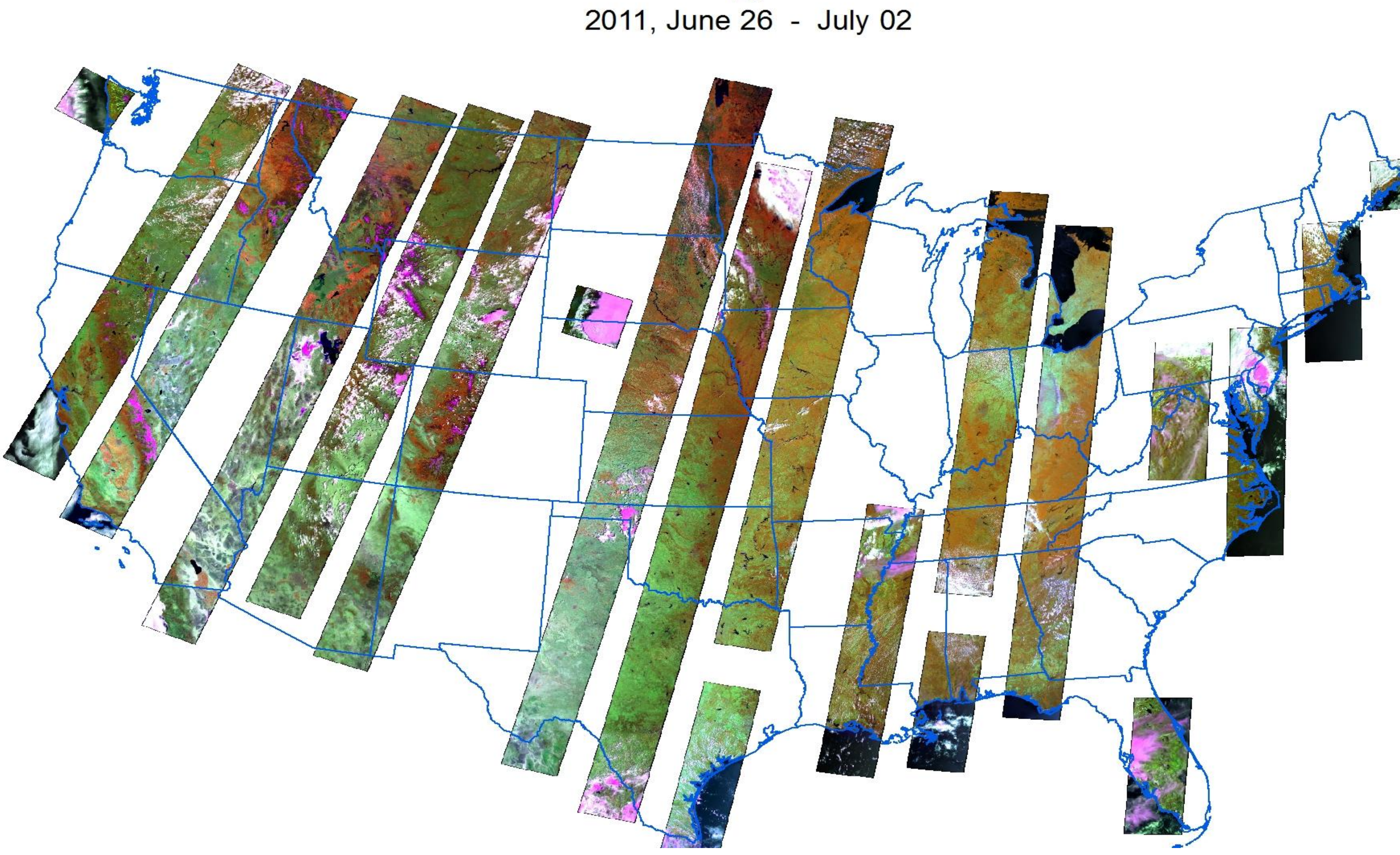
July 15



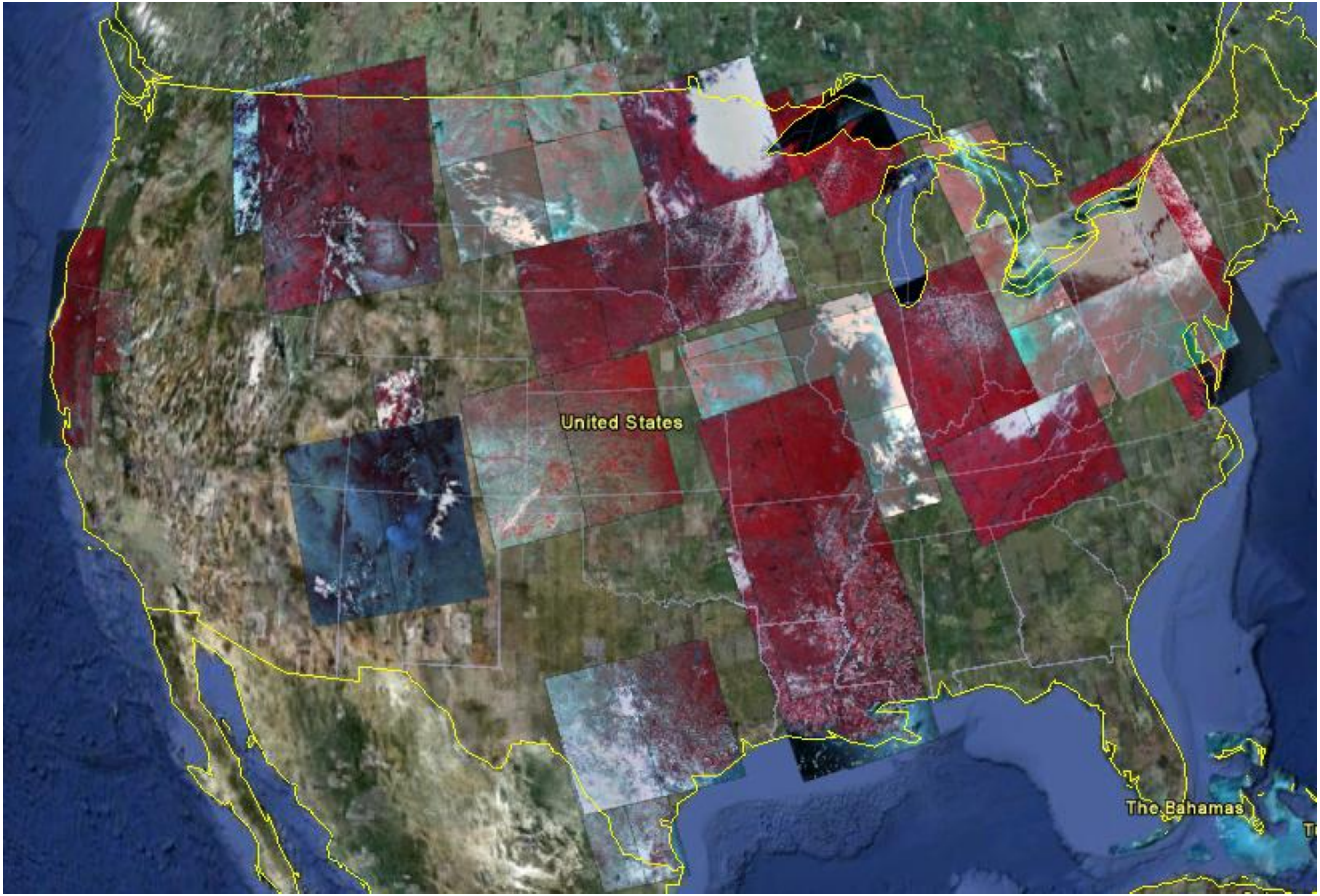
Aug 27



Landsat 5 Collections



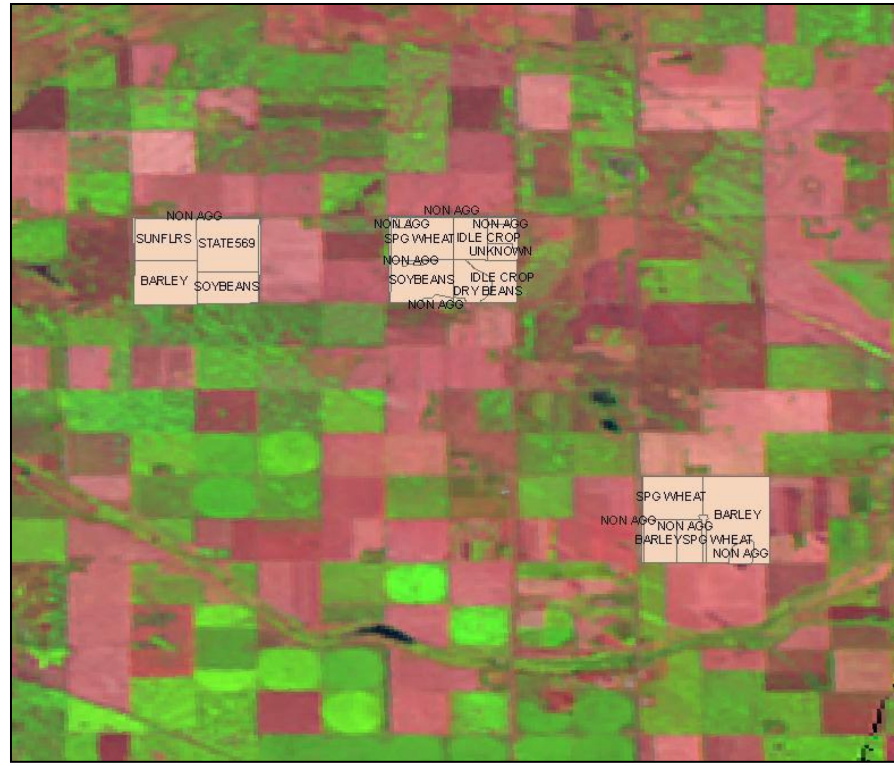
Deimos-1/UK2 Collections



June 27 – July 2, 2011

Agricultural Ground Truth

USDA United States Department of Agriculture
Farm Service Agency



Farm Service Agency (FSA)

Common Land Unit (CLU)

Form 578 reported data (current year)

NASS

June Agricultural Survey

Ground Truth – Land Cover

Agriculture Ground Truth

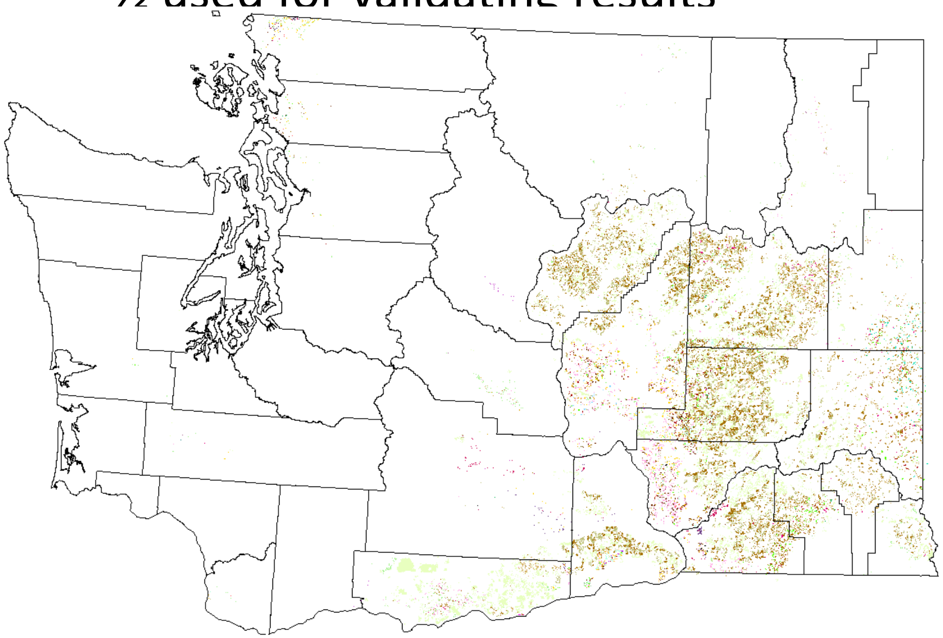
Provided by Farm Service Agency

Identifies known fields and crops

Divide known fields into 2 sets

½ used for training software

½ used for validating results

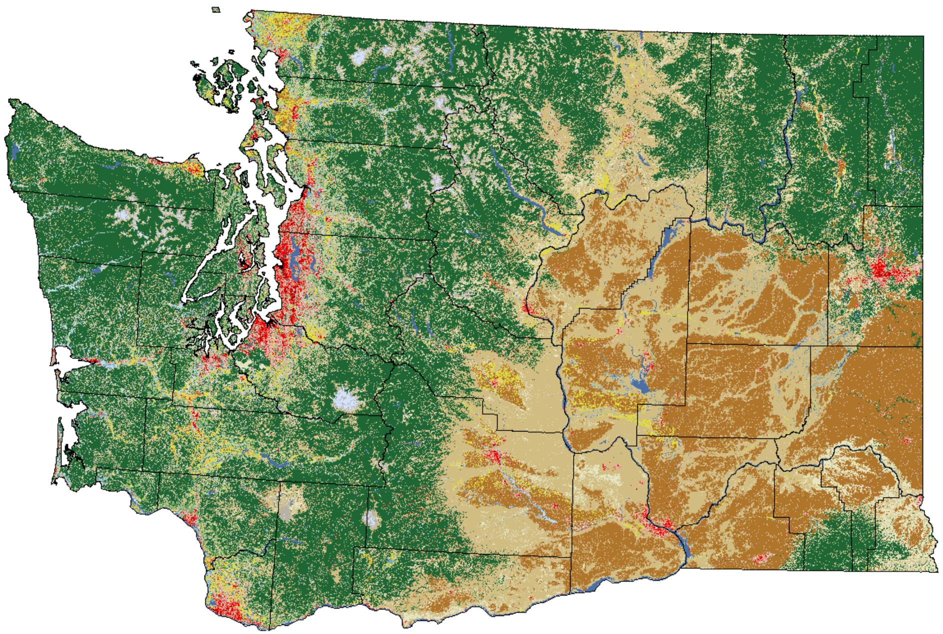


Non-Agriculture Ground Truth

USGS National Land Cover Dataset

Identifies urban infrastructure and non-agriculture land cover

Forest, grass, water, cities



Software Suite

Ground Truth Preparation
•ESRI ArcMap

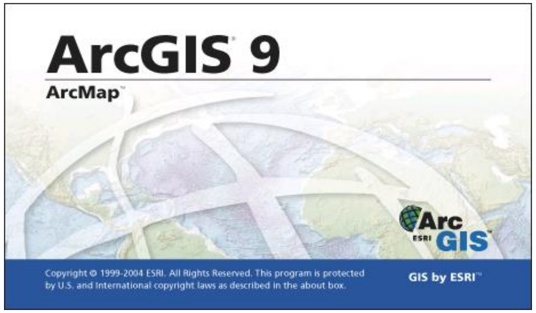
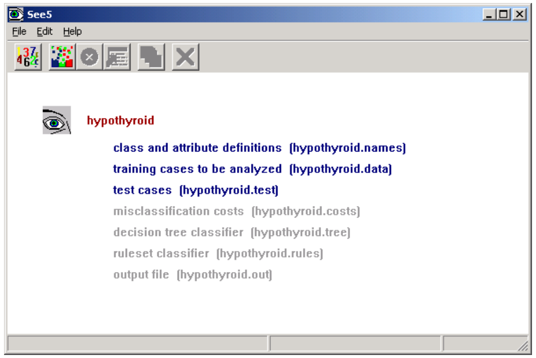


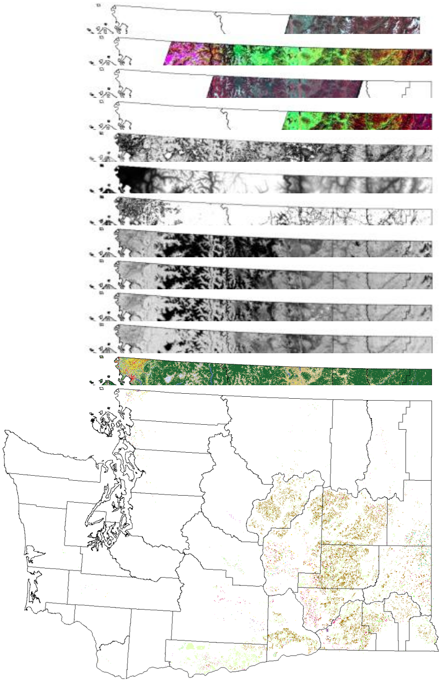
Image Preparation
•Leica Geosystems ERDAS Imagine 9.1

Image Classification
•See 5



Acreage Estimates
•SAS/IML Workshop

Processing a CDL



Satellite Imagery

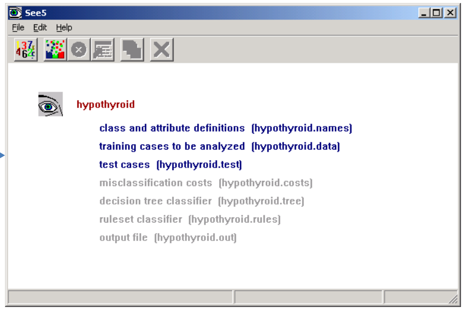
Ancillary Data

MODIS Data

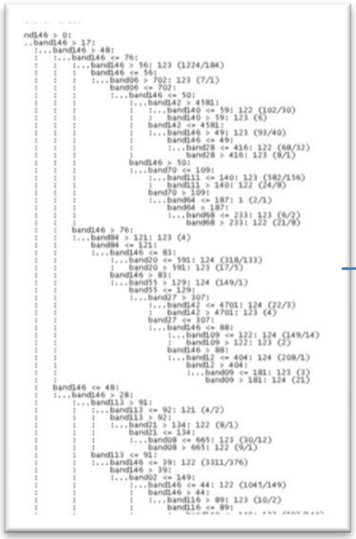
Ground Truth

Sampling

See5

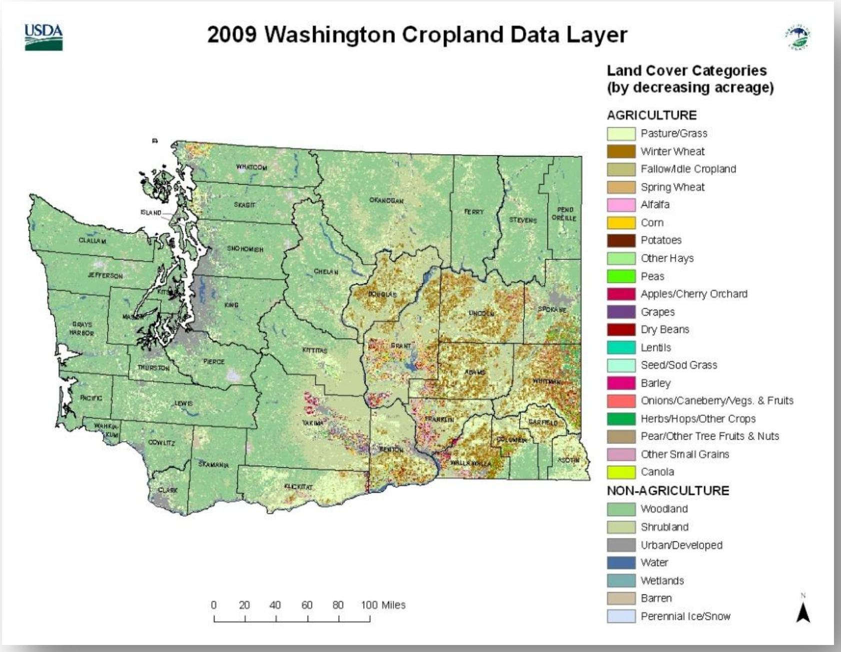


Decision Tree



```
nd146 > 0:
..band146 > 17:
  :...band146 > 48:
  :   :...band146 <= 76:
  :   :   :...band146 > 56: 123 (1224/184)
  :   :   :   band146 <= 56:
  :   :   :   :...band06 > 702: 123 (7/1)
  :   :   :       band06 <= 702:
  :   :   :       :...band146 <= 50:
  :   :   :           :...band142 > 4581:
  :   :   :           :   :...band140 <= 59: 122 (102/30)
  :   :   :           :   :   band140 > 59: 123 (6)
  :   :   :           :   band142 <= 4581:
  :   :   :           :   :...band146 > 49: 123 (93/40)
  :   :   :           :       band146 <= 49:
  :   :   :           :       :...band28 <= 416: 122 (68/32)
  :   :   :           :           band28 > 416: 123 (8/1)
  :   :   :           band146 > 50:
  :   :   :           :...band70 <= 109:
  :   :   :               :...band111 <= 140: 123 (582/156)
  :   :   :               :   band111 > 140: 122 (24/8)
  :   :   :               band70 > 109:
  :   :   :               :...band64 <= 187: 1 (2/1)
  :   :   :                   band64 > 187:
  :   :   :                   :...band68 <= 233: 123 (6/2)
  :   :   :                       band68 > 233: 122 (21/8)
  :   :   band146 > 76:
  :   :   :...band84 > 121: 123 (4)
  :   :       band84 <= 121:
  :   :       :...band146 <= 83:
  :   :           :...band20 <= 591: 124 (318/133)
  :   :           :   band20 > 591: 123 (17/5)
  :   :           band146 > 83:
  :   :           :...band55 > 129: 124 (149/1)
  :   :               band55 <= 129:
  :   :               :...band27 > 307:
  :   :                   :...band142 <= 4701: 124 (22/3)
  :   :                   :   band142 > 4701: 123 (4)
  :   :                   band27 <= 307:
  :   :                   :...band146 <= 88:
  :   :                       :...band109 <= 122: 124 (149/14)
  :   :                       :   band109 > 122: 123 (2)
  :   :                       band146 > 88:
  :   :                       :...band12 <= 404: 124 (208/1)
  :   :                           band12 > 404:
  :   :                           :...band09 <= 181: 123 (3)
  :   :                               band09 > 181: 124 (21)
  :   band146 <= 48:
  :   :...band146 > 28:
  :       :...band113 > 91:
  :       :   :...band113 <= 92: 121 (4/2)
  :       :   :   band113 > 92:
  :       :   :   :...band21 > 134: 122 (8/1)
  :       :   :       band21 <= 134:
  :       :   :       :...band08 <= 665: 123 (30/12)
  :       :   :           band08 > 665: 122 (9/1)
  :       :   band113 <= 91:
  :       :   :...band146 <= 39: 122 (3311/376)
  :       :       band146 > 39:
  :       :       :...band02 <= 149:
  :       :           :...band146 <= 44: 122 (1045/149)
  :       :           :   band146 > 44:
  :       :           :   :...band116 > 89: 123 (10/2)
  :       :           :       band116 <= 89:
```

Classification



Validating CDLs

We measure the accuracy of each CDL

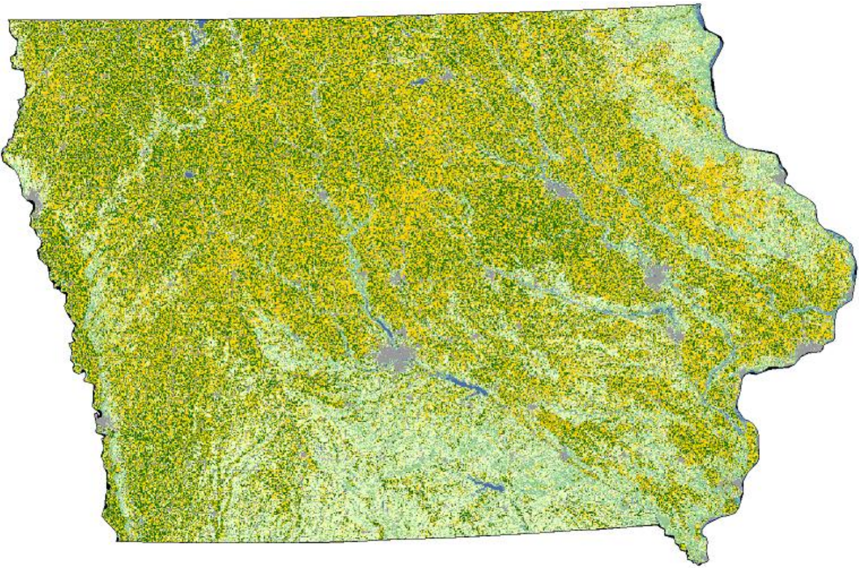
Compare:

Classified pixels from CDL
Known pixels, not used for classifying imagery, from FSA

Track:

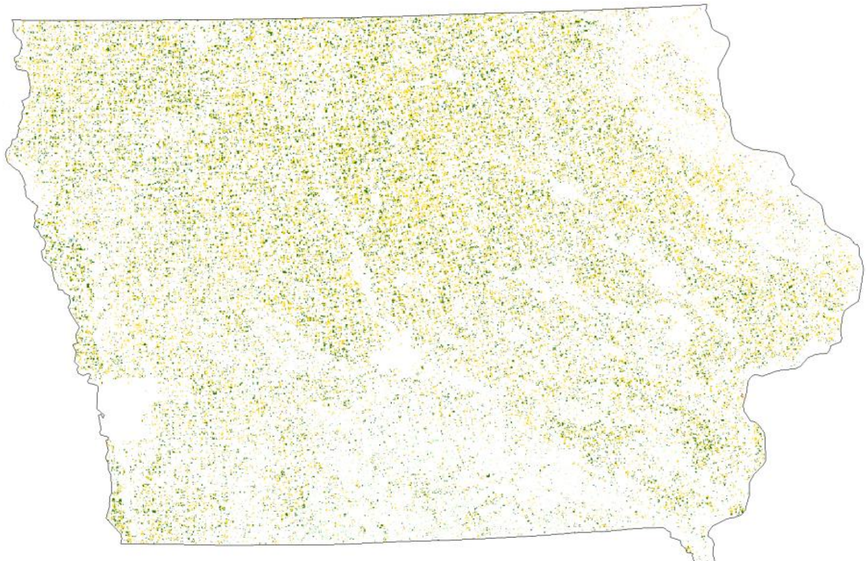
Producer Accuracy - Errors of Omission - % of pixels from category missing
User Accuracy - Errors of Commission - % of pixels from category that are over classified

Cropland Data Layer



versus

Groundtruth – ½ saved for validation



Accuracy Assessments

	Cover Type	Attribute Code	*Correct Pixels	Producer's Accuracy	Omission Error	Kappa	User's Accuracy	Commission Error	Cond'l Kappa
IA	Corn	1	2197719	96.58%	3.42%	0.9226	97.86%	2.14%	0.9509
	Soybeans	5	1471094	96.24%	3.76%	0.9392	95.78%	4.22%	0.9320
IL	Corn	1	2258219	98.06%	1.94%	0.9527	98.58%	1.42%	0.9650
	Soybeans	5	1339089	96.36%	3.64%	0.9438	97.96%	2.04%	0.9681
NE	Corn	1	1856422	97.29%	2.71%	0.9605	97.32%	2.68%	0.9608
	Soybeans	5	849249	95.83%	4.17%	0.9513	96.95%	3.05%	0.9643
SD	Corn	1	803251	94.29%	5.71%	0.9342	95.78%	4.22%	0.9513
	Soybeans	5	707383	95.03%	4.97%	0.9439	97.72%	2.28%	0.9741

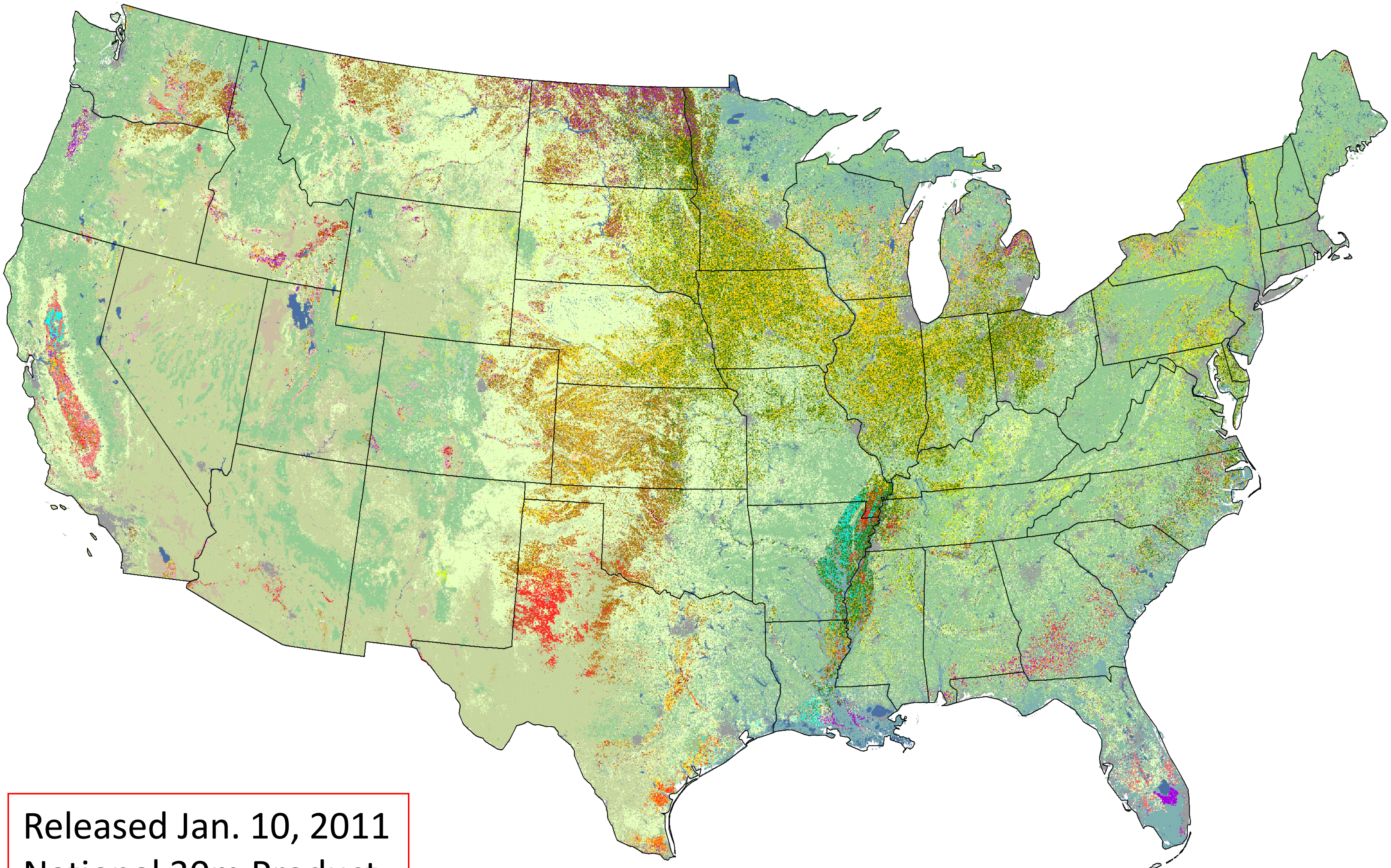
	Crop-specific covers only	*Correct	Accuracy	Error	Kappa
IA	OVERALL ACCURACY	3688803	95.74%	4.26%	0.9145
IL	OVERALL ACCURACY	3730093	97.05%	2.95%	0.9426
NE	OVERALL ACCURACY	3071960	94.05%	5.95%	0.8981
SD	OVERALL ACCURACY	2306428	87.51%	12.49%	0.8416

State level accuracies are very high

Producer's Accuracy: relates to the probability that a ground truth pixel will be correctly mapped and measures errors of omission.
Errors of Omission: occur when a pixel is excluded from the correct category.
User's Accuracy: indicates the probability that a pixel from the classification actually matches the ground truth data and measures errors of commission.
Errors of Commission: occur when a pixel is included in an incorrect category.
Kappa Coefficient: A statistics measure of agreement, beyond chance, between two maps.

2010 Cropland Data Layers

Inputs: Landsat (8601 scenes) AWiFS (1194 scenes)



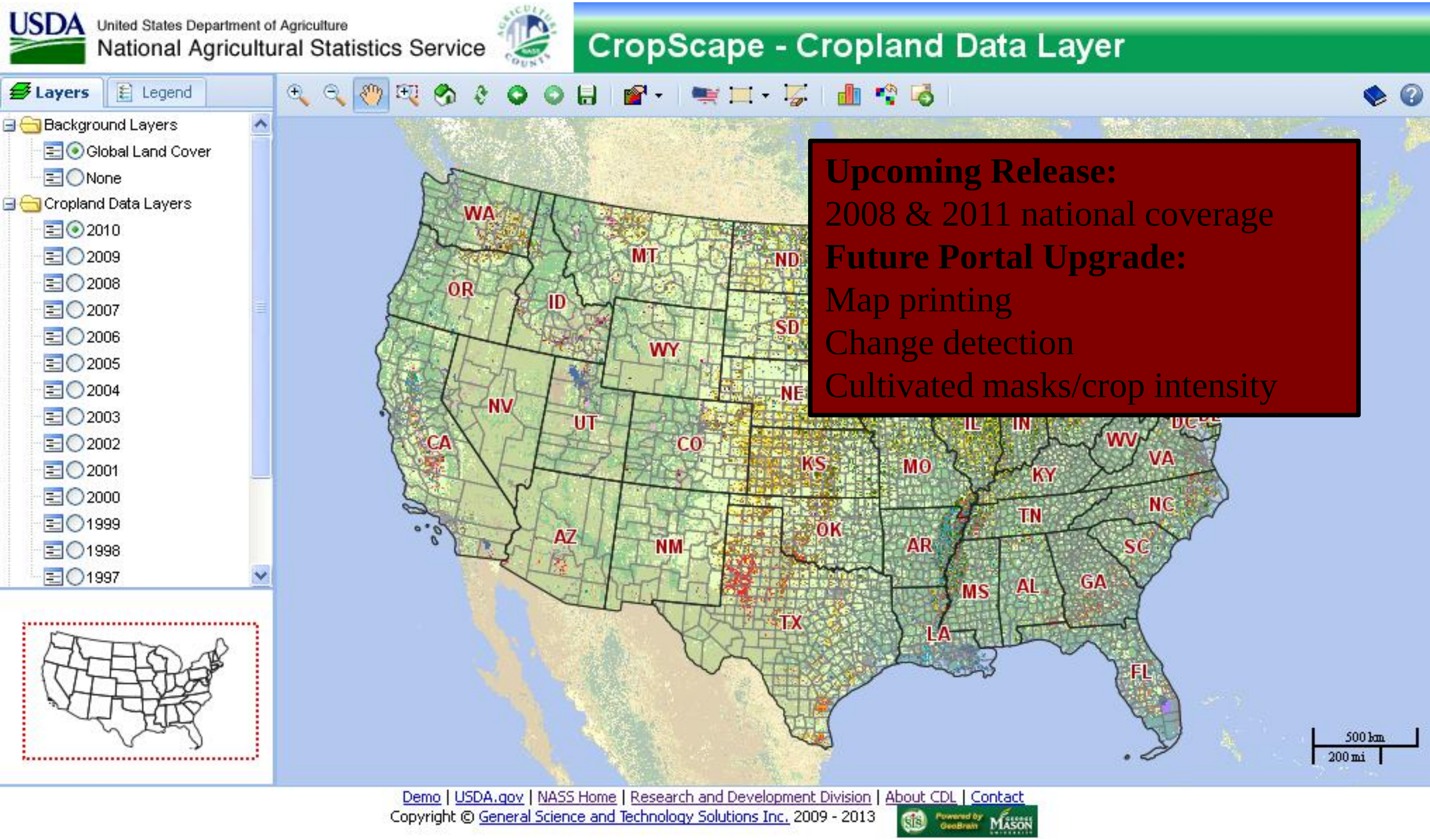
Released Jan. 10, 2011
National 30m Product

~ 9 billion pixels!

How Competitive Are the Remote Sensing Indications for Planted Acres?

Highly Competitive	Moderately Competitive	Not in the Game
Corn	Alfalfa	Other Hay
Soybeans	Sorghum	Fruits
Winter Wheat	Sugarcane	Vegetables
All Cotton	Barley	Small Area Crops
Spring Wheat	Oats	
Fall Potatoes	Tobacco	
All Rice		
Sugarbeets		
Peanuts		
Durum Wheat		
All Dry Beans		
Sunflower		
Canola		

CropScape Portal



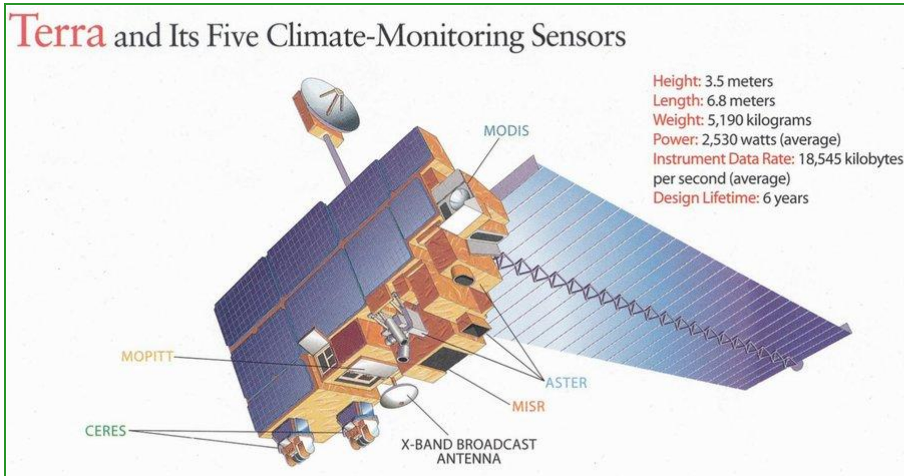
Upcoming Release:
2008 & 2011 national coverage

Future Portal Upgrade:
Map printing
Change detection
Cultivated masks/crop intensity

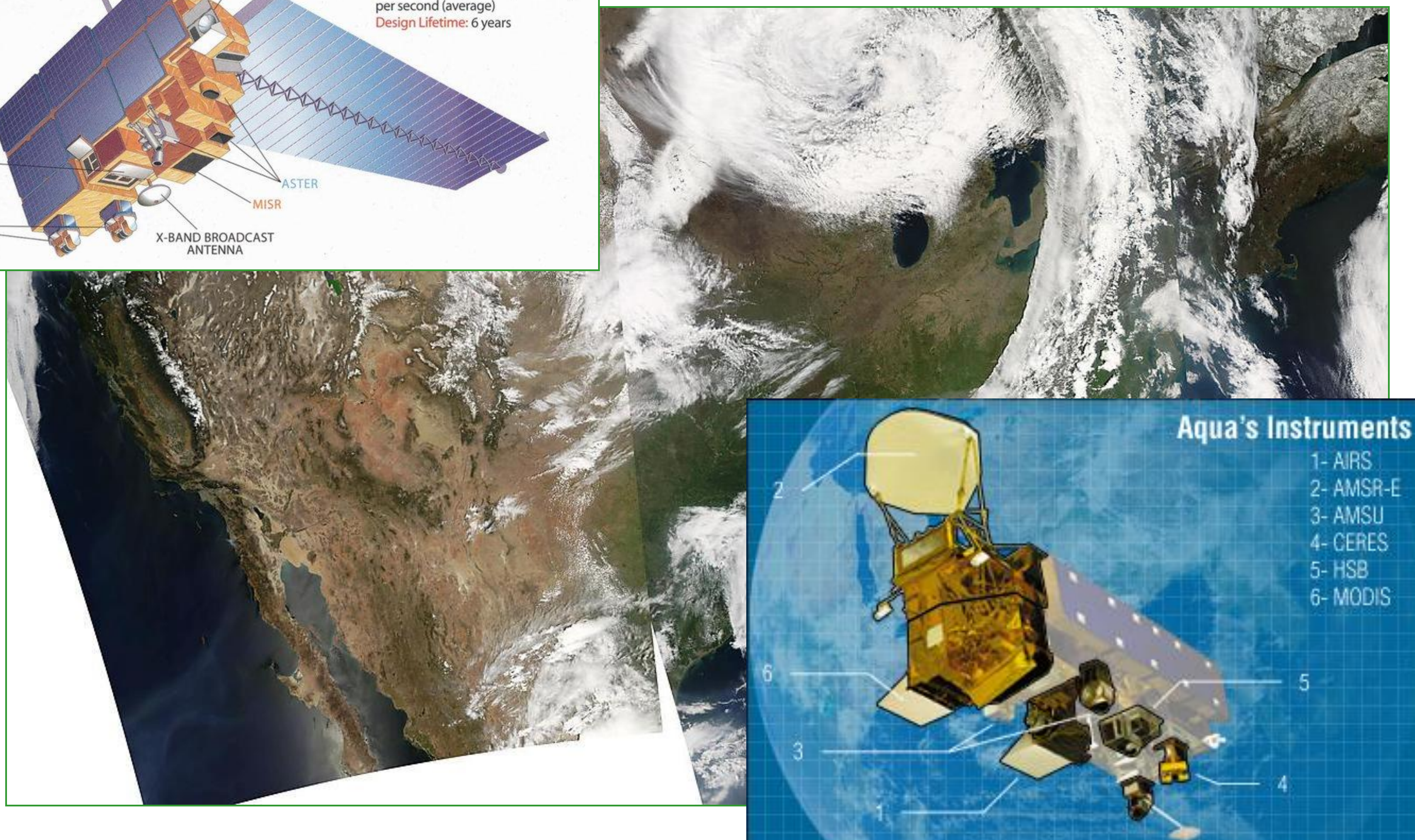
nassgeodata.gmu.edu/CropScape

Corn and Soybean Yields *via* Remote Sensing

Sensor: MODerate resolution Imaging Spectroradiometer (MODIS)

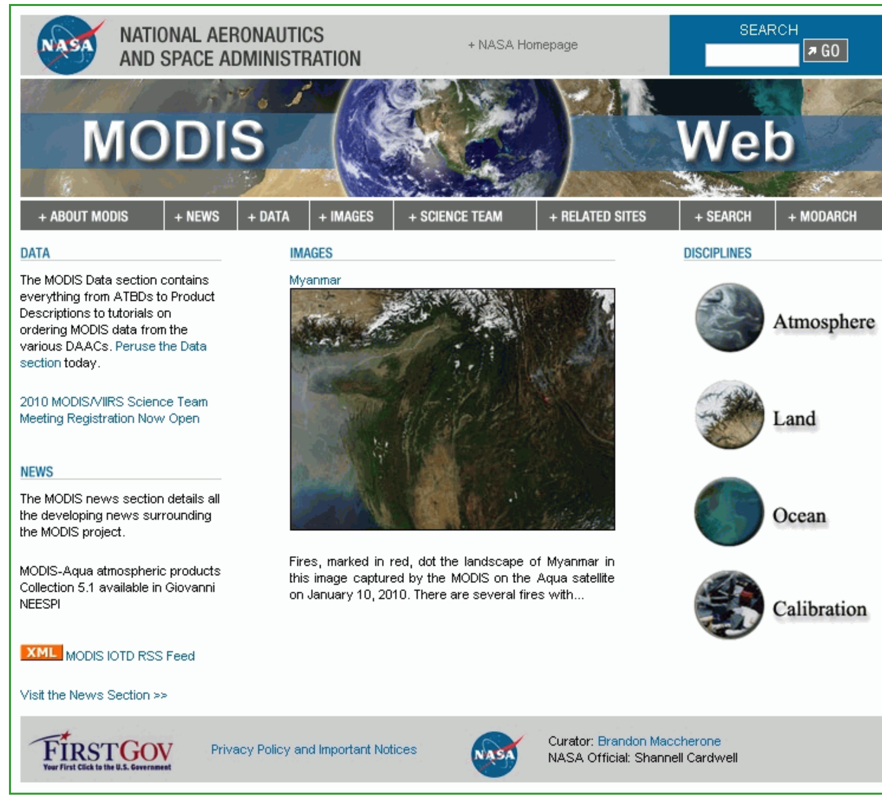


Onboard the NASA **Terra** and **Aqua** satellites



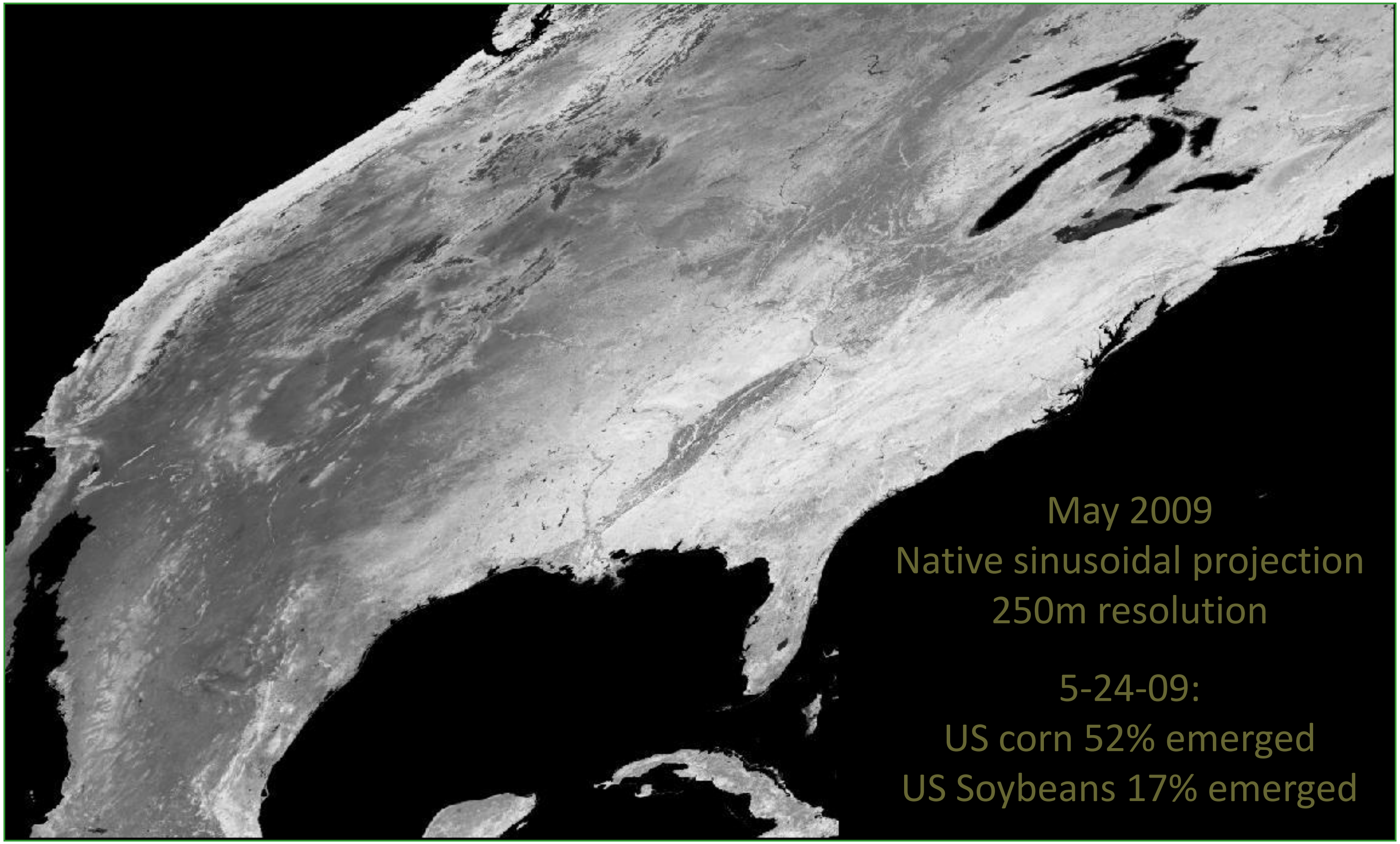
MODIS key facts

- Global coverage
- Daily revisit rate
- 15 acre (250m) ground level pixel resolution
  - from red and near-infrared bands
- Composite "best of" image mosaics automatically generated
  - 8 and 16-day temporal windows
- Timely
  - most data usually available within 24 hours
- It's Free!
  - downloaded via ftp
- Launched in 1999 and 2002
  - Reliable history
- 6 year design life but still functioning fine



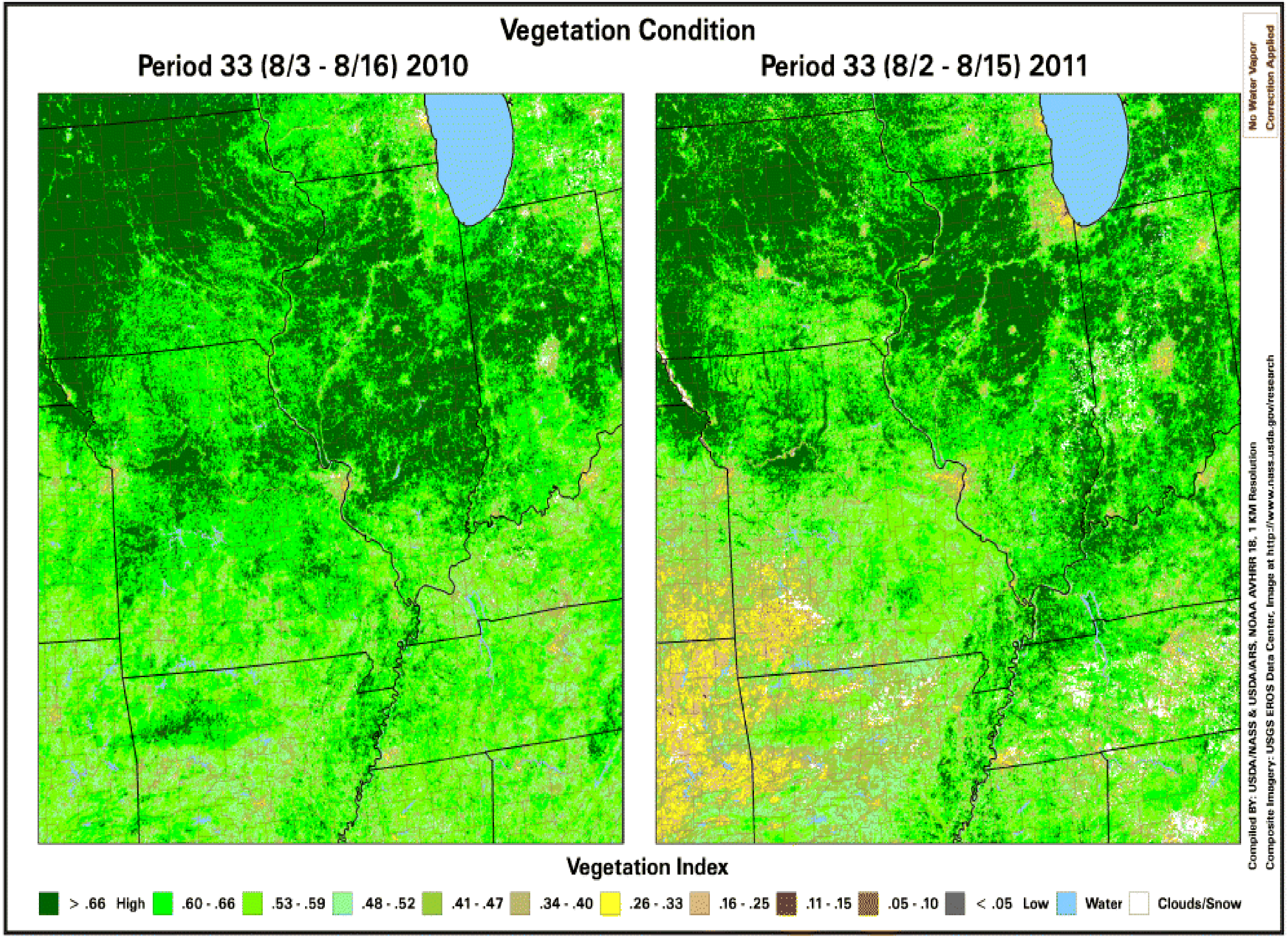
modis.gsfc.nasa.gov

Sample Terra MODIS Normalized Difference Vegetation Index (NDVI) “greenness” composite

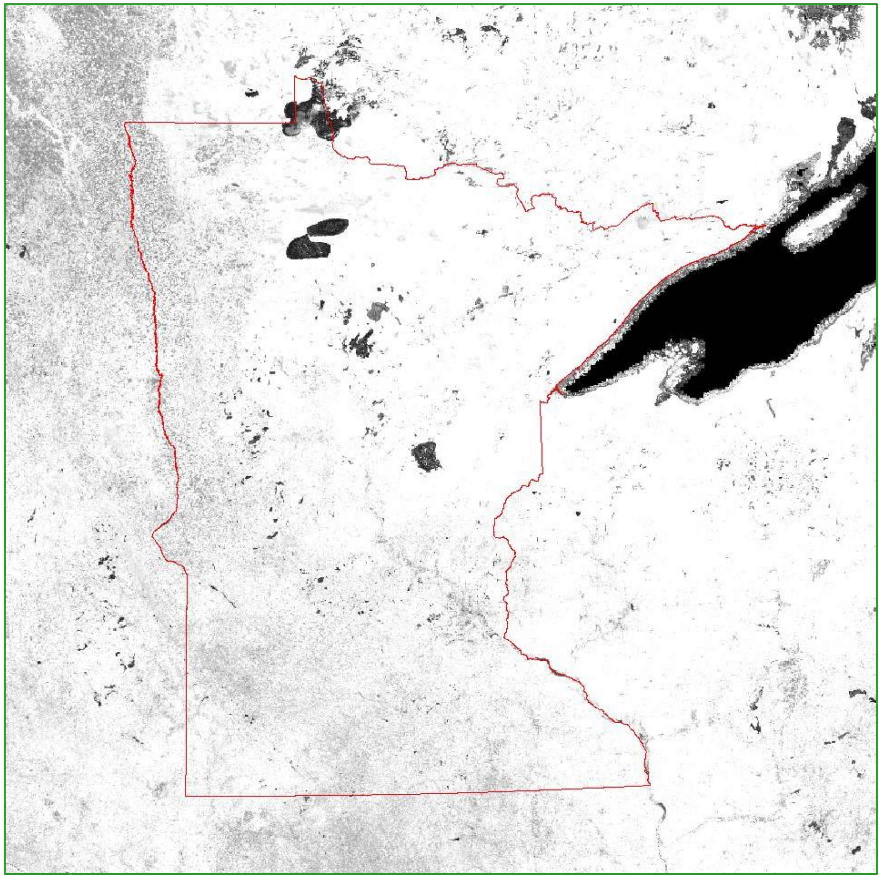


In terms of surface reflectance spectra:

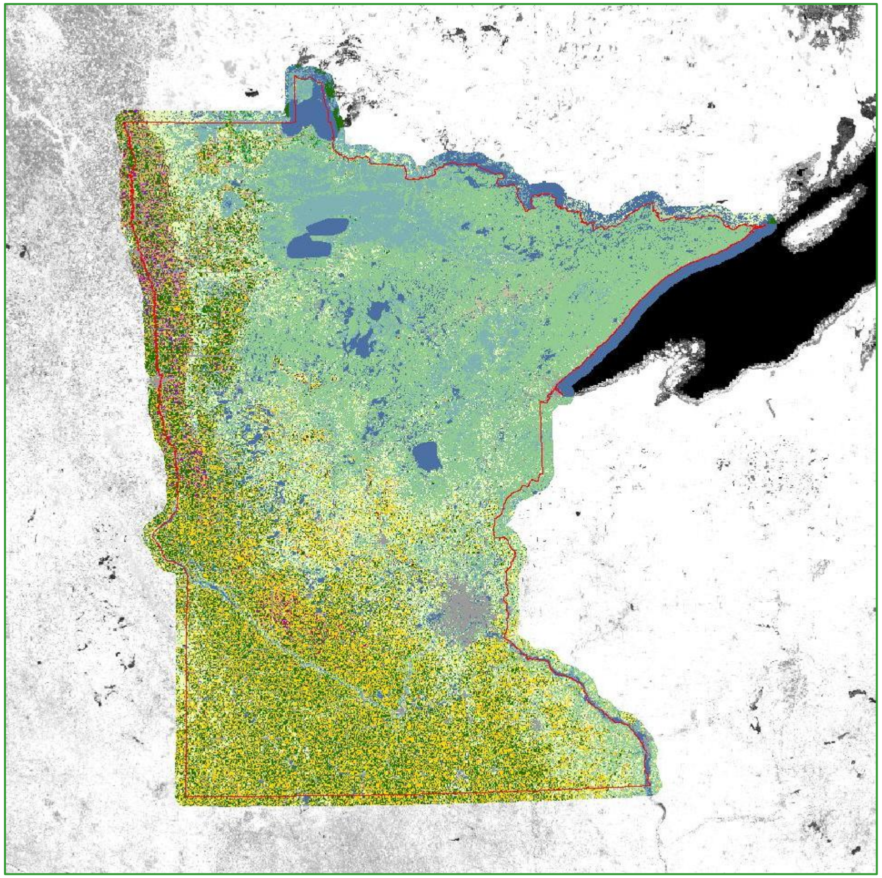
NDVI = (near infrared – visible red) / (near infrared + visible red)


Vegetation Condition
Period 33 (8/3 - 8/16) 2010
Period 33 (8/2 - 8/15) 2011
No Water Vapor Correction Applied
Vegetation Index
> .66 High
.60 - .66
.53 - .59
.48 - .52
.41 - .47
.34 - .40
.26 - .33
.16 - .25
.11 - .15
.05 - .10
< .05 Low
Water
Clouds/Snow
Compiled BY: USDA/NASS & USDA/ARS, NOAA AVHRR 18, 1 KM Resolution
Composite Imagery: USGS EROS Data Center, Image at http://www.nass.usda.gov/research

Extract Crop Specific Pixels

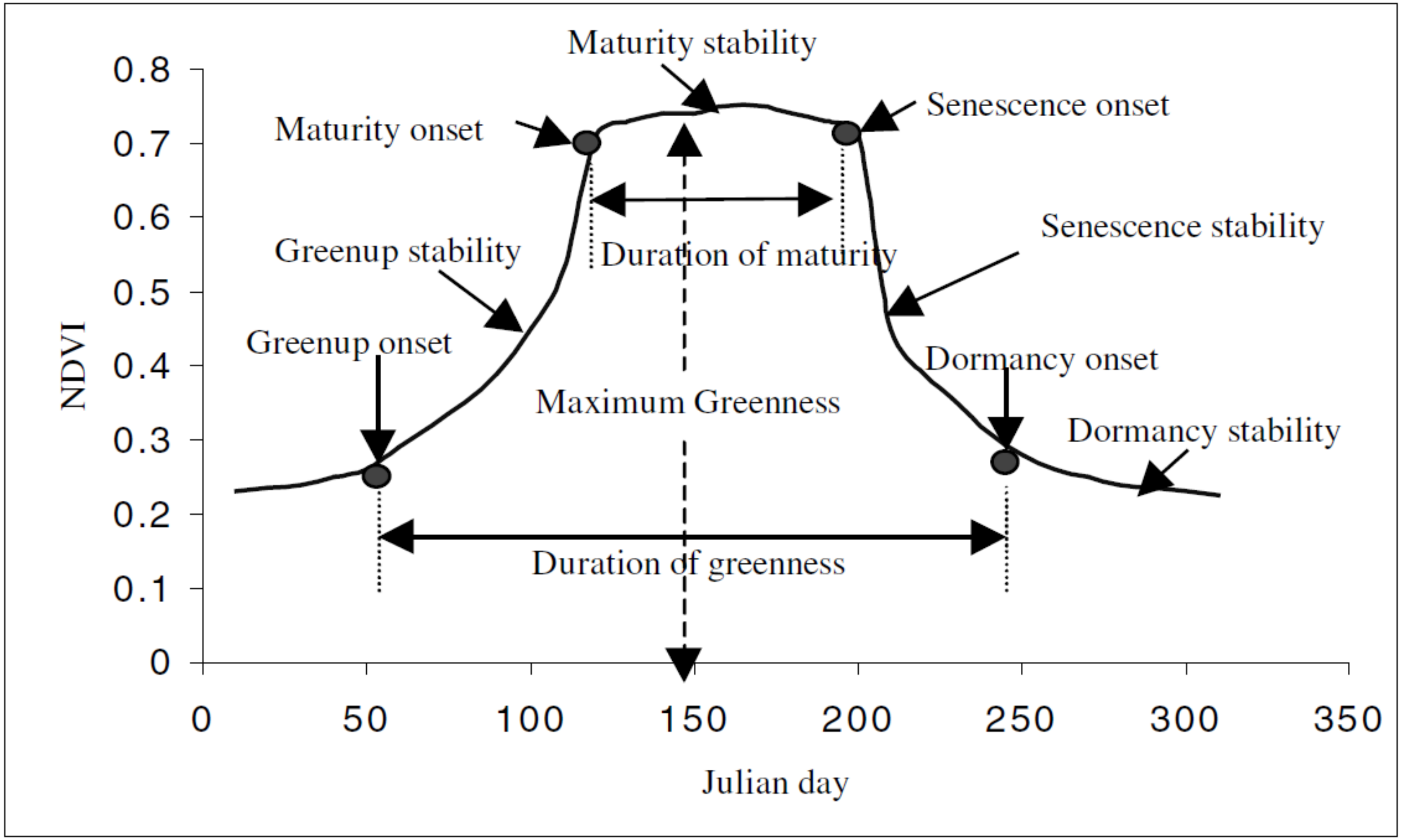


Example MODIS NDVI from Sept. 2009



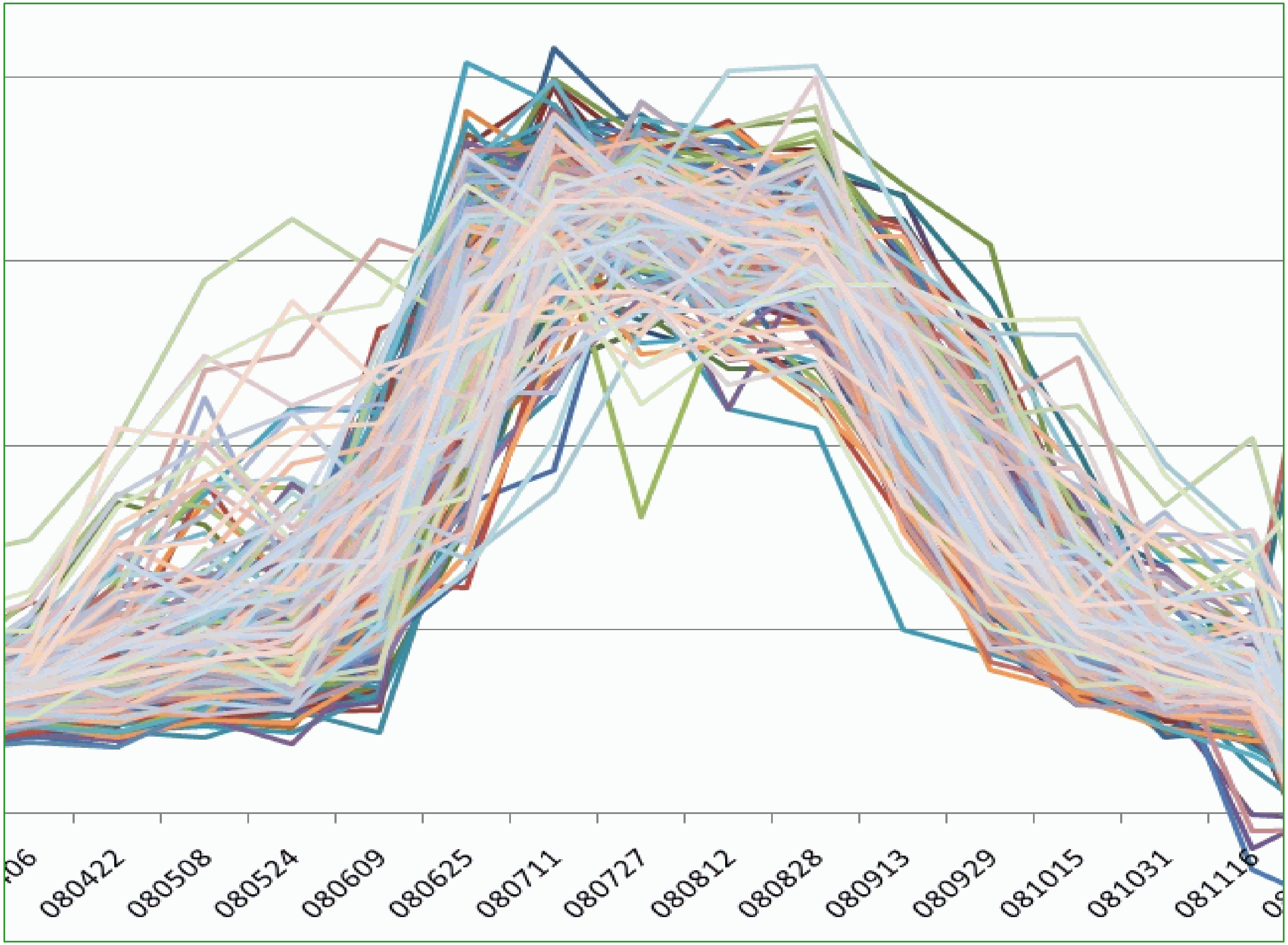
2009 Cropland Data Layer

Determining Phenological Metrics

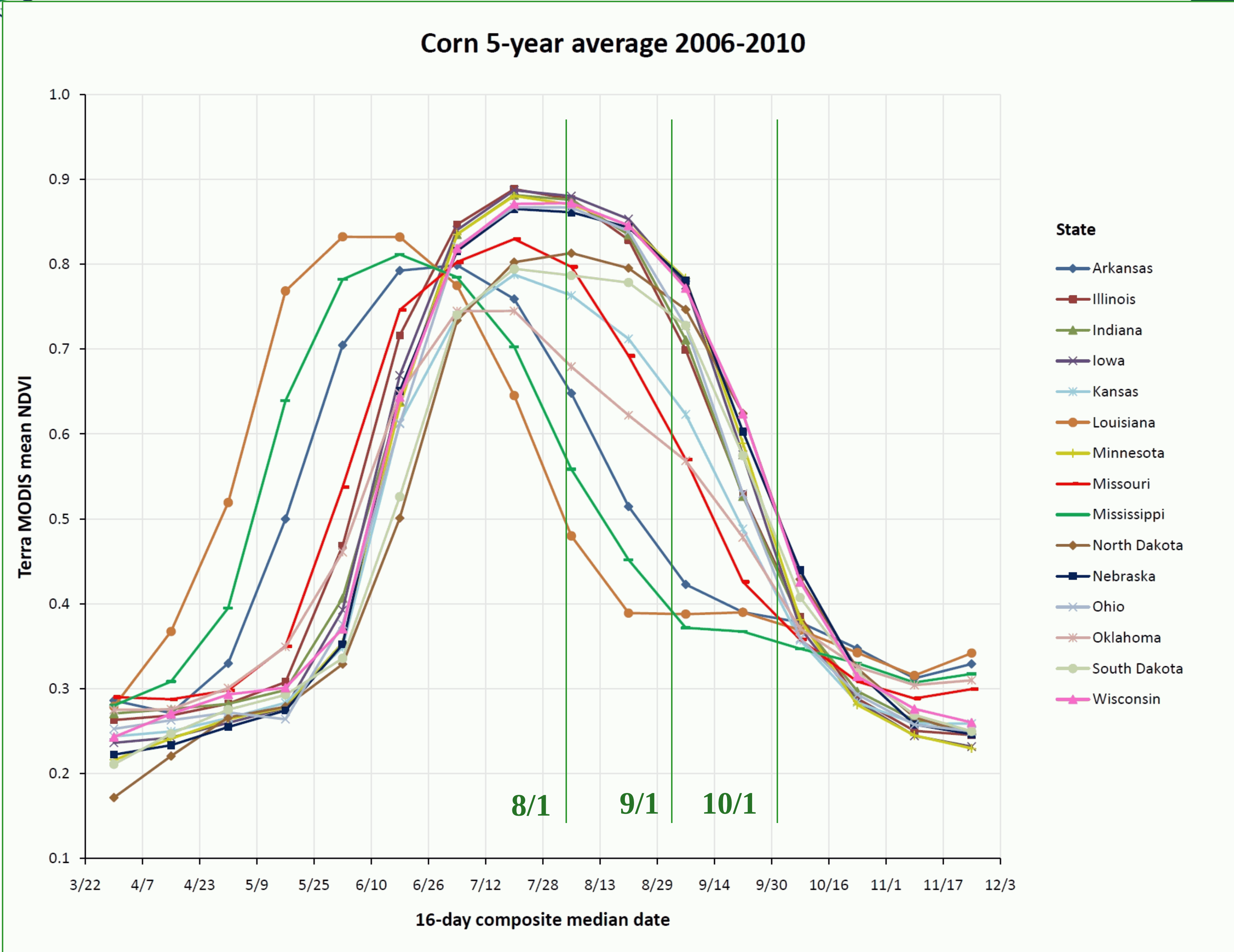


From Zhang et al., "Monitoring vegetation phenology using MODIS," Remote Sensing of Environment, 84:471–475, 2003.

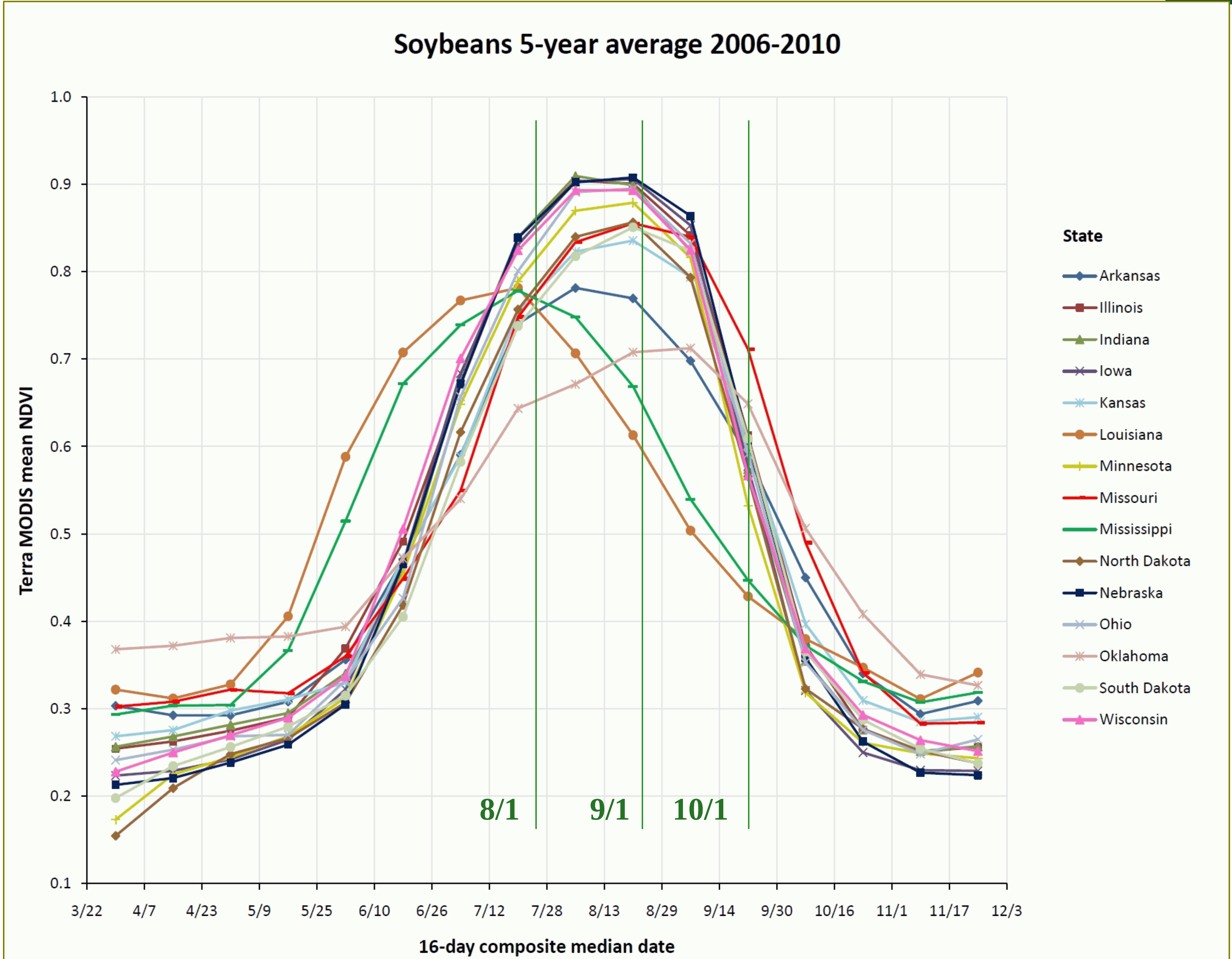
NDVI “Curves” for Each Corn Pixel



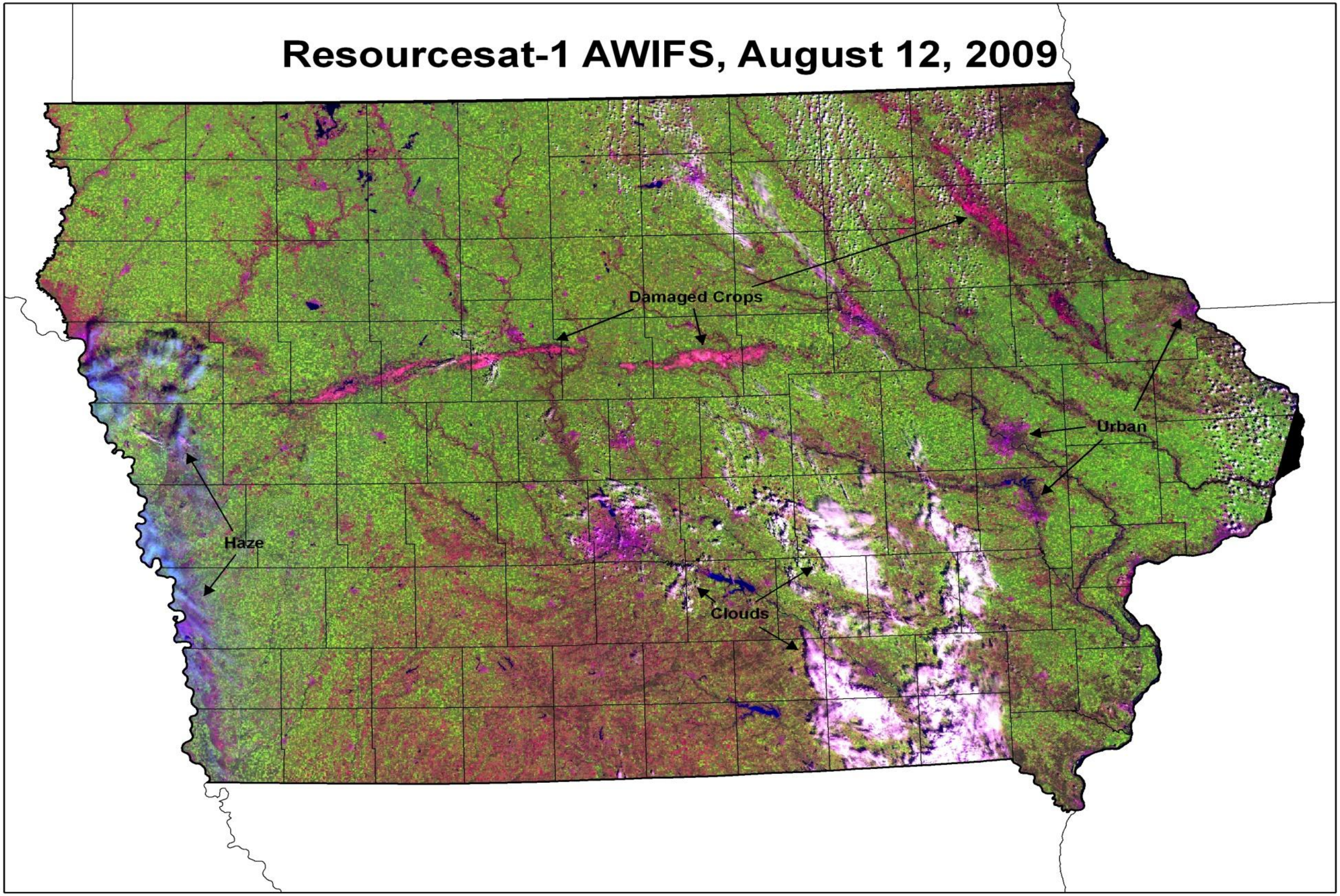
State Average Corn Phenologies



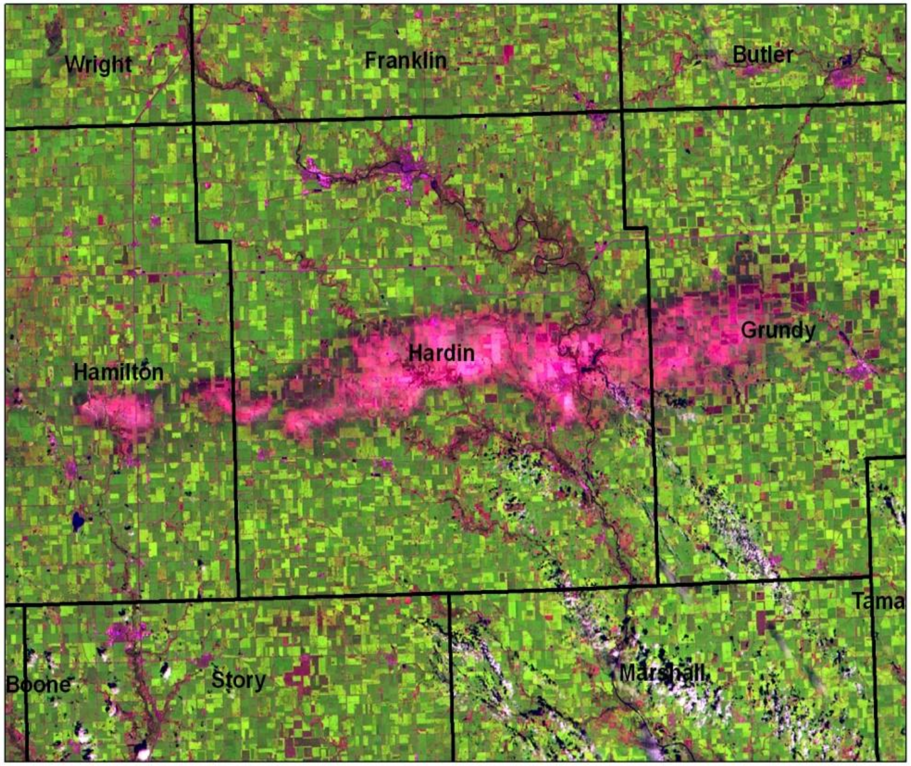
State Average Soybean Phenologies

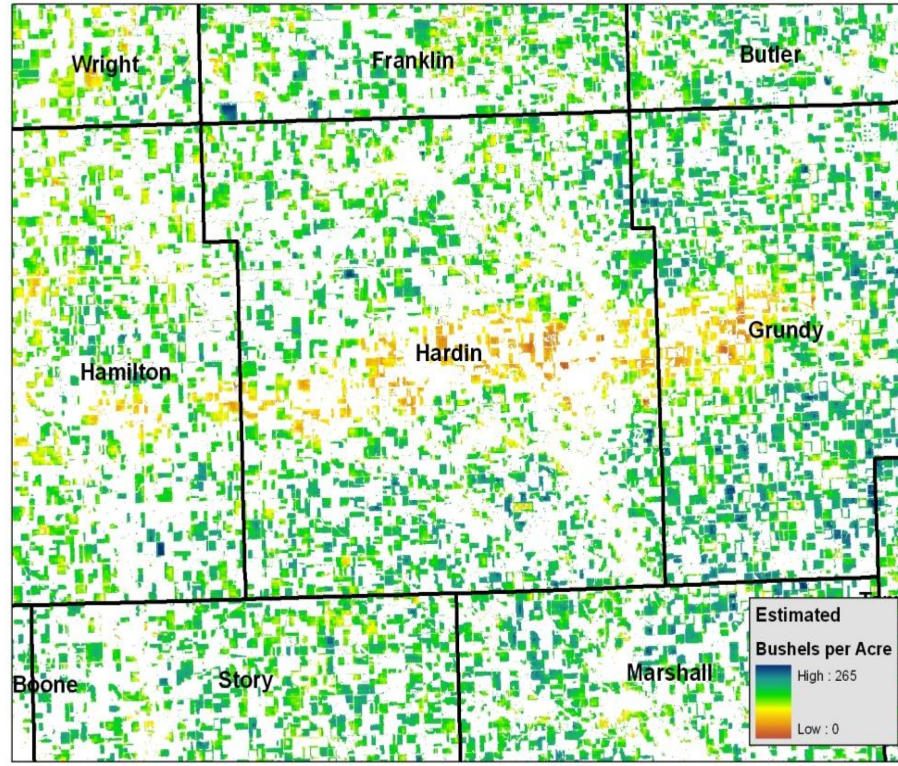


Natural Disaster Assessments – Visual Reference



From Reality to Modeled Yield

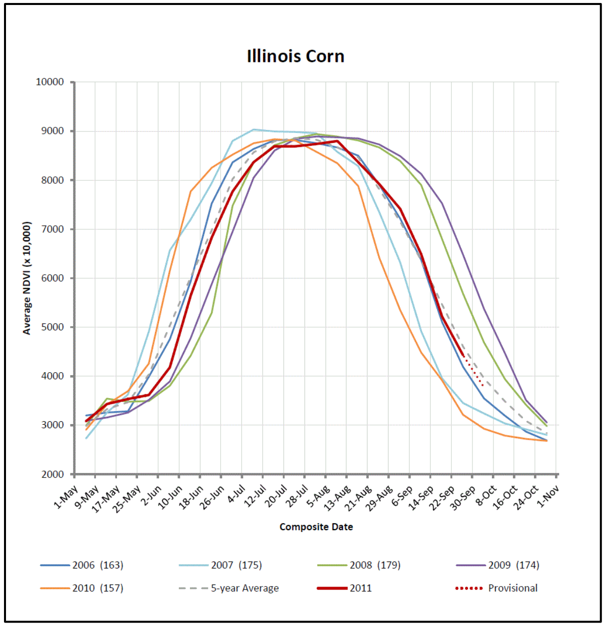




"Largest Hailstorm Ever"- Mapping the Disaster with the Yield Model

2011 Weekly Corn Yield Reports

Generated every Monday for ASB from
July 6th through October 3rd



Corn Phenology and Yield Report
August 1, 2011

PHENOLOGY

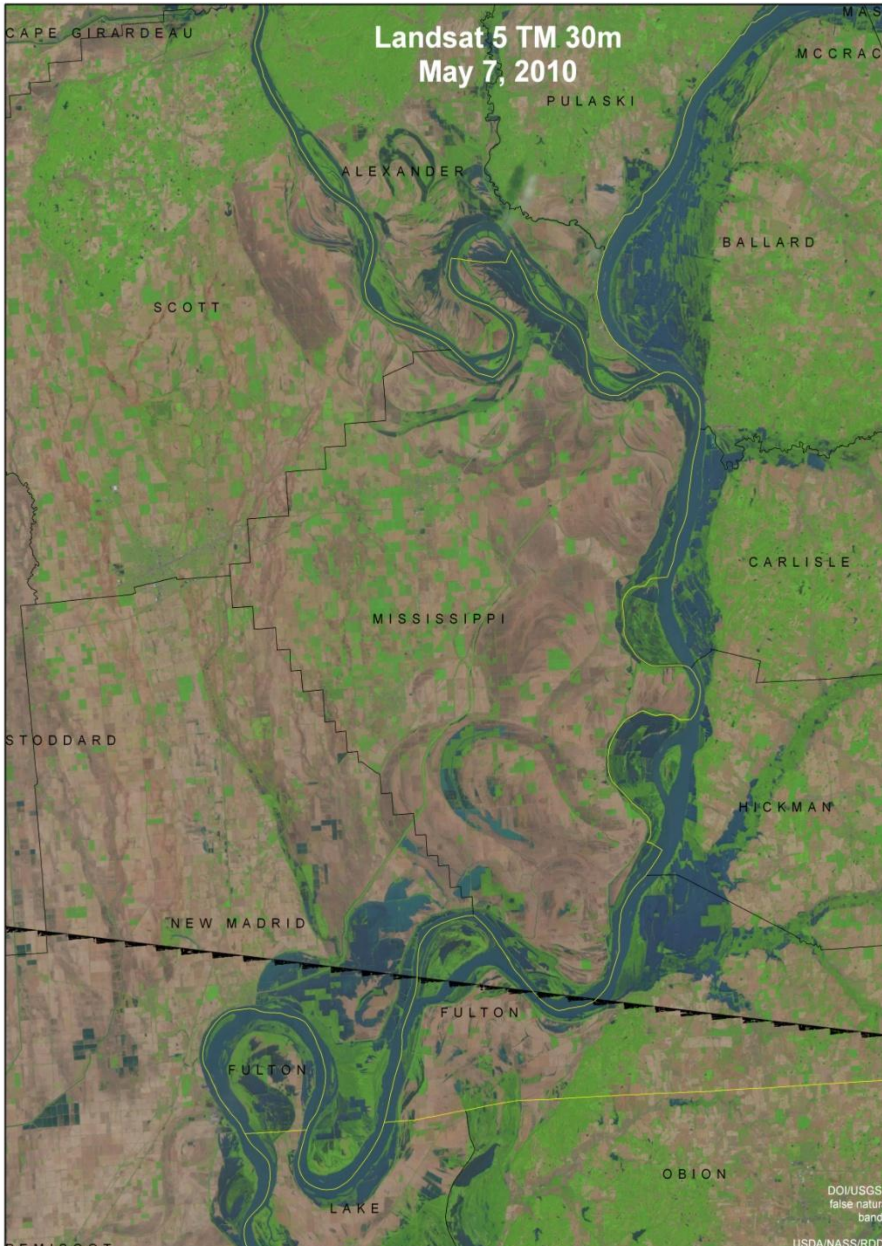
YIELD

Spec Region	8/8	8/15	8/22	8/29	9/5	9/12	9/19	9/26	10/1	%Δ	RMSE
Illinois											
Indiana											
Iowa											
Kansas											
Minnesota											
Missouri											
Nebraska											
Ohio											
South Dakota											
Wisconsin											

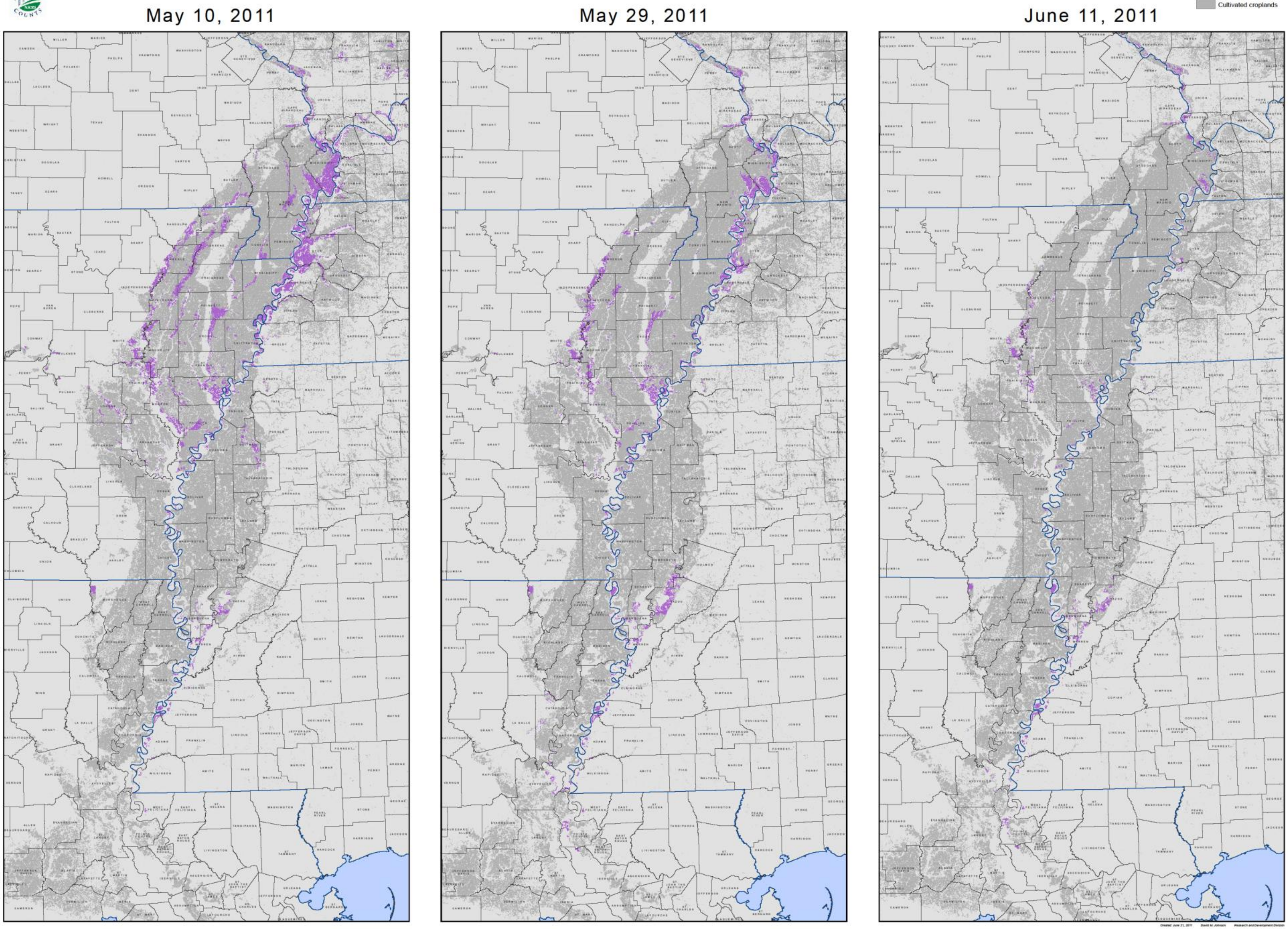
Main concepts:

- Provide yield intel between Crop Reports
- Test feasibility
- Promote the idea that remote sensing estimates could be produced in a relatively easy fashion

Disaster Assessment Products



Satellite-derived Cultivated Cropland Inundation Areas



Operational Summary

- SARS Remote Sensing Acreage Program continues to evolve and improve despite multiple challenges. Staff and flexible processing capabilities are keys to success.

- SARS Remote Sensing Yield Program shows excellent results for corn yields, only good results for soybeans. Weekly reports a big plus for NASS intelligence. Program needs more research & maturity.

- Ad Hoc Disaster Monitoring/Assessments have been needed in each of last 5 years, but needs to be more mature & systematic.

- Dissemination products, *CropScape* and Yield Maps (internal only), are unique and ahead of their time.

- SARS products are the most operationally advanced in the world. We're not just about producing "pretty pictures."

Crop Progress and Condition

Crop Progress

ISSN: 1948-3007

Released July 25, 2011, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

Cotton Squaring – Selected States

[These 15 States planted 99% of the 2010 cotton acreage]

State	Week ending			2006-2010 Average
	July 24, 2010	July 17, 2011	July 24, 2011	
	(percent)	(percent)	(percent)	(percent)
Alabama	85	50	64	85
Arizona	93	85	90	95
Arkansas	100	97	99	99
California	90	75	80	92
Georgia	96	70	80	91
Kansas	83	68	79	84

Monthly *Crop Production* Reports

- Released monthly
  - But crop progress and condition can change significantly in days!
- Not enough time or resources to conduct nationwide farmer surveys each week

Crop Progress

- Released each week
- Crop items change as the crop develops
- Subjective estimates based on standard definitions

- **Key Word - *SUBJECTIVE***

Background:

- Data collected weekly from April through November
- Approximately 5,000 reporters Nationally
- Attempt to have at least one in each county
- Goal is 80% response
- Usually FSA/Extension agents

It is antiquated, but is also:

- Cheap
- Fast
- Decades (centuries?) of history
- Relatively accurate
- Remote sensing NOT READY YET

On The Horizon

Remote Sensing-Based U.S. National Crop Progress Monitoring System (NCPMS)

Zhengwei Yang[1,2], Liping Di[2], Genong Yu[2], Rick Mueller[1]
[1]Research and Development Division, USDA NASS
[2]Center for Spatial Information System Science
George Mason University
Zhengwei_yang@nass.usda.gov

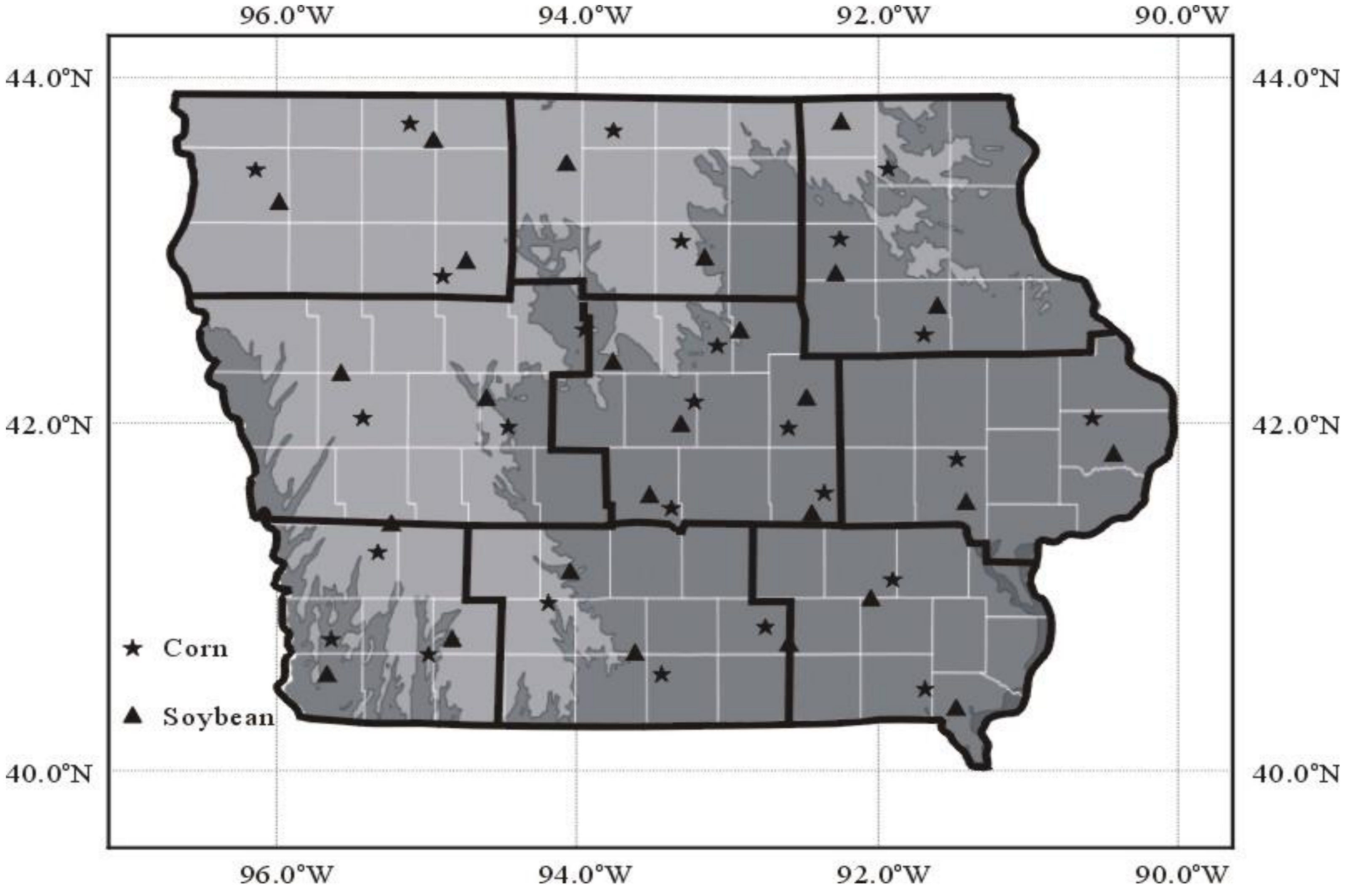
Project Goals

- To support and enhance the monitoring of nationwide crop progress and conditions at NASS
  - Develop science-based crop progress metrics
  - Develop and prototype an operational National Crop Progress Monitoring System (NCPMS)
- To enhance the NASS crop progress and condition data accessibility, interoperability and dissemination

New "Geospatial" Science and Research Needed

- ***Crop Progress*** **– Provide quantitative assessments by stage of development for each specific crop.**
- ***Crop Conditions*** **– Quantitatively assess the amount of a specific crop in very poor, poor, fair, good, and excellent condition.**
- ***Soil Moisture*** **- Monitoring and assessing Topsoil (surface to 6" depth) and Subsoil (>6"-- 3-4') moisture in categories similar to the following - Very short, Short, Adequate, Surplus.**
- ***Natural Disaster Monitoring & Assessment*** **- timely monitoring & assessing significant events affecting crop area, conditions and yield**

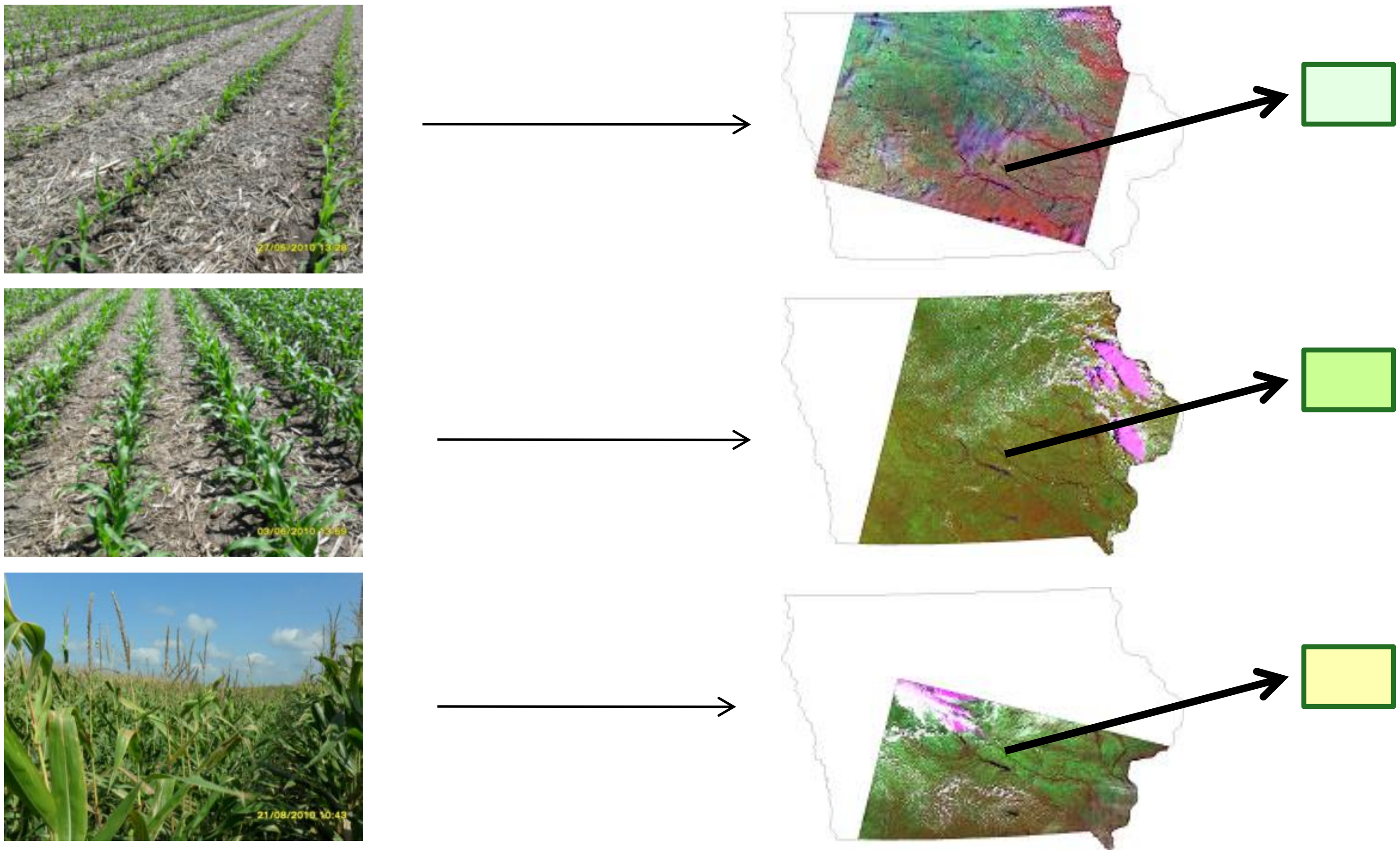
Test Sites



Distribution of test sites in Iowa

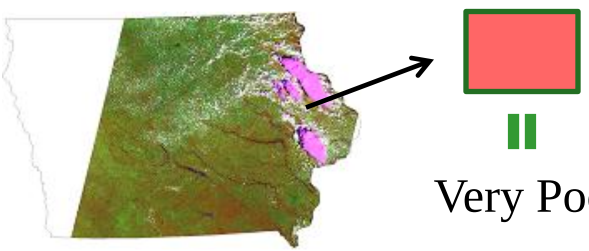
Ground Truth Data Needed to Build "Model" (establish a relationship)

<u>Observed corn field:</u> <u>Satellite data:</u>



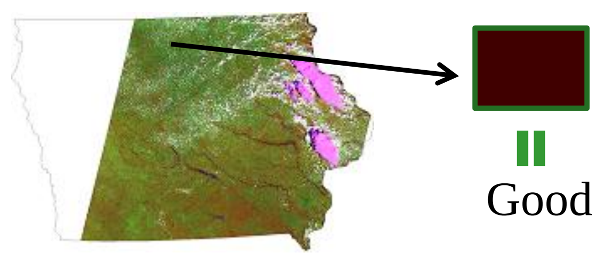
Crop development can be observed and change can be measured by analyzing satellite imagery throughout the growing season.

Inferences can also be made on crop condition



=

Very Poor



=

Good

Estimate this Unknown Pixel as Poor? Fair?

The <u>more data</u> we have, the more confident we can be in our estimations

Hopefully, someday . . . . .

Estimates like these:

Statewide Crop Conditions as of August 8, 2010

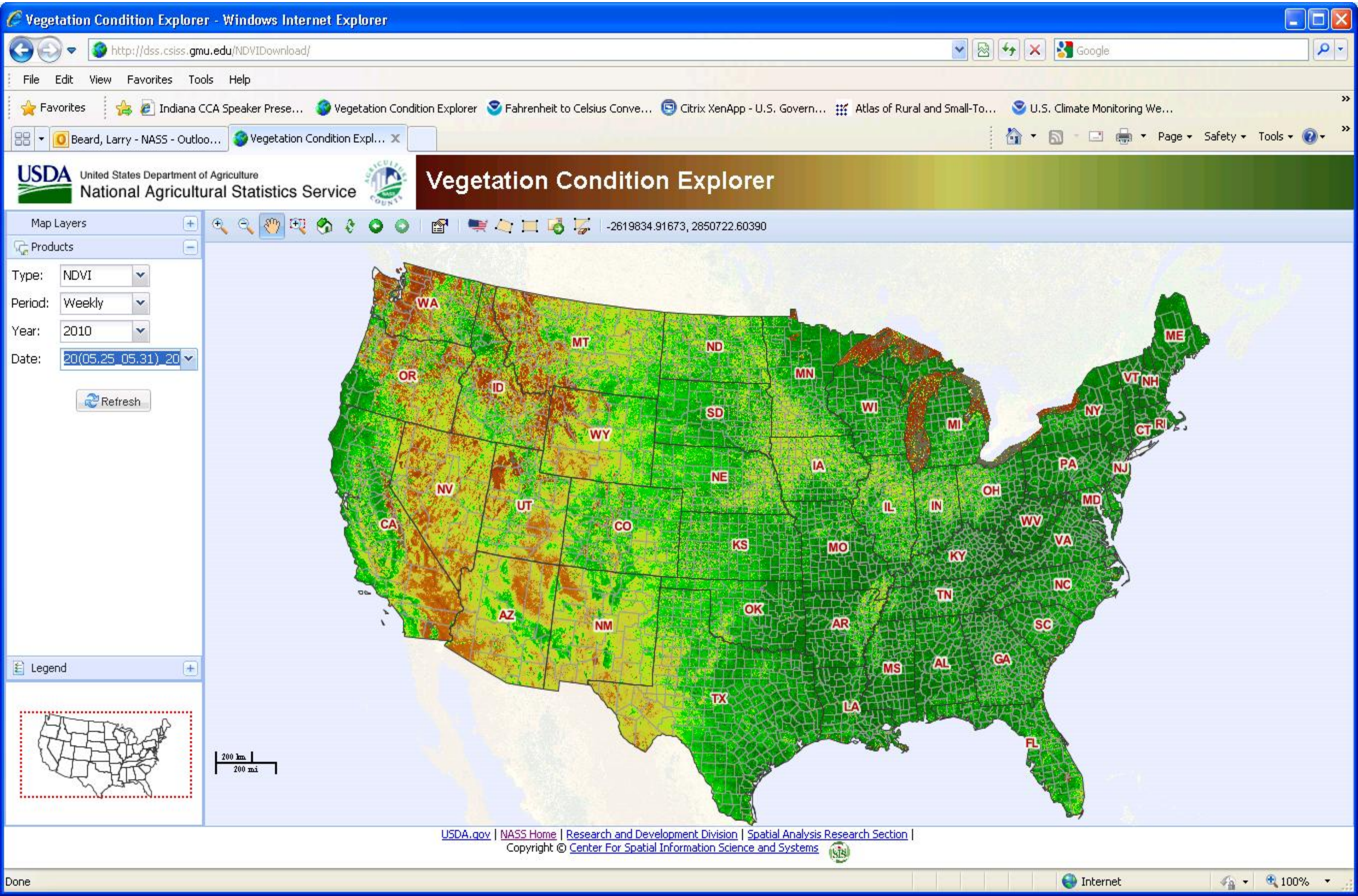
Item	Very Poor	Poor	Fair	Good	Excellent
	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)
Corn	3	8	19	45	25
Soybeans	3	6	18	48	25

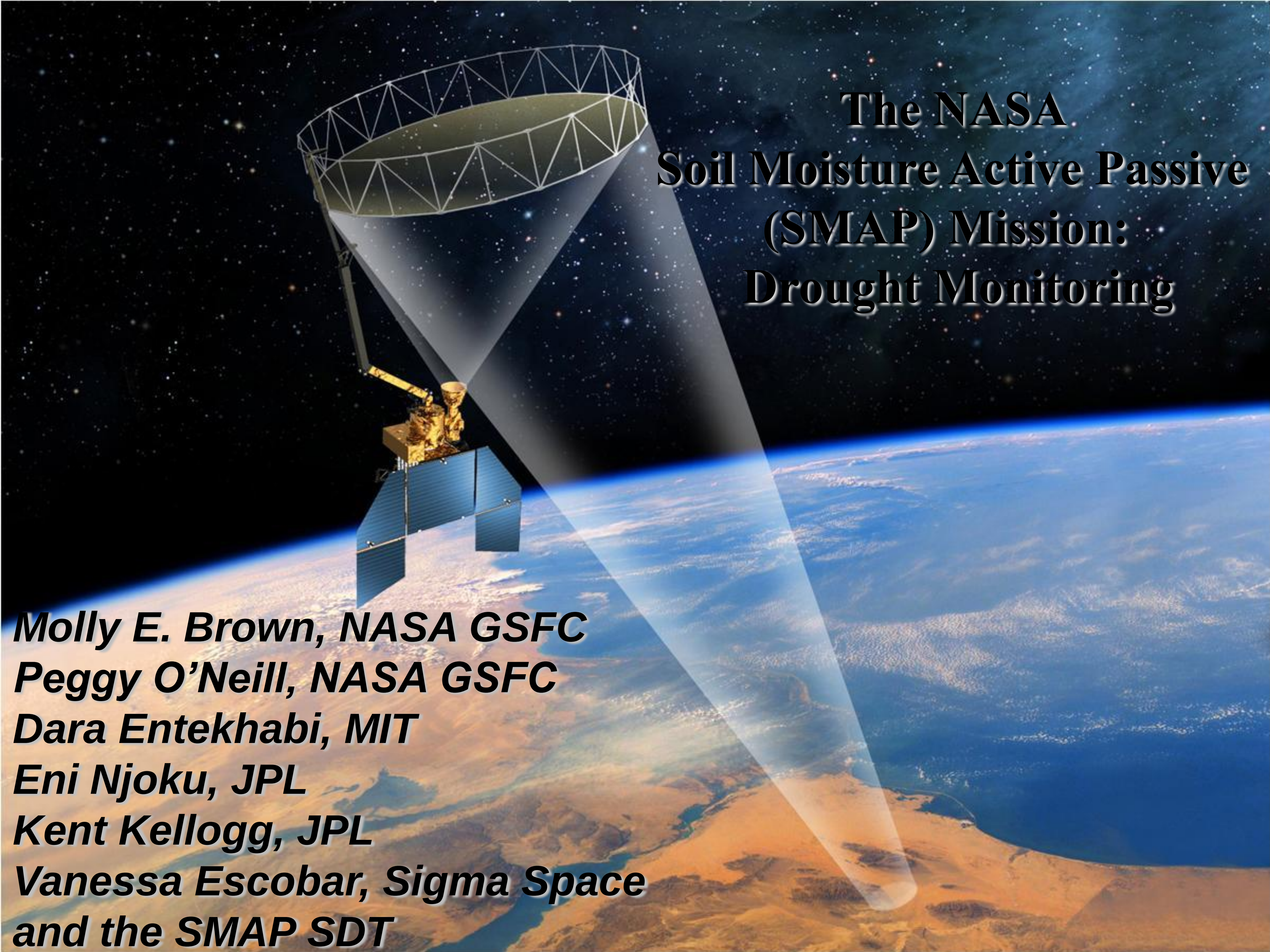
Field Work and Crop Progress as of August 8, 2010

Item	Districts									State	Last Week	Last Year	5-yr Avg
	NW	NC	NE	WC	C	EC	SW	SC	SE				
	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)
Corn silked	99	100	97	98	100	99	95	94	95	98	94	89	94
Corn in or past milk stage	70	89	75	91	94	84	72	68	66	81	54	45	63
Corn in or past dough stage	24	50	27	51	52	34	27	35	27	38	12	10	28
Soybeans bloomed	100	99	98	99	100	97	95	90	90	97	91	94	95
Soybeans setting pods	89	88	73	86	93	83	72	63	60	82	63	76	79

Will be developed ***objectively*** using satellite imagery, and displayed like this:

New VegScape Prototype





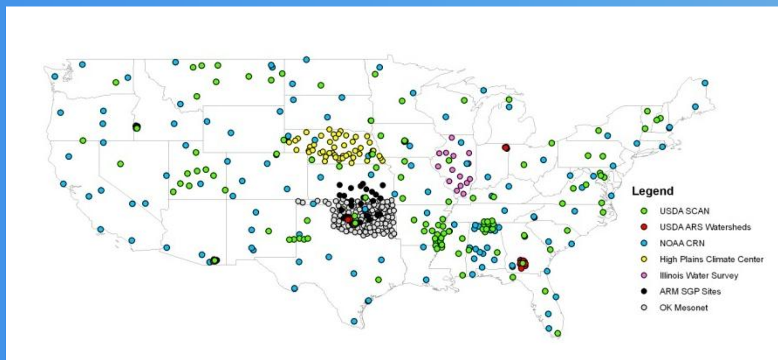
The NASA Soil Moisture Active Passive (SMAP) Mission: Drought Monitoring

Molly E. Brown, NASA GSFC
Peggy O'Neill, NASA GSFC
Dara Entekhabi, MIT
Eni Njoku, JPL
Kent Kellogg, JPL
Vanessa Escobar, Sigma Space
and the SMAP SDT

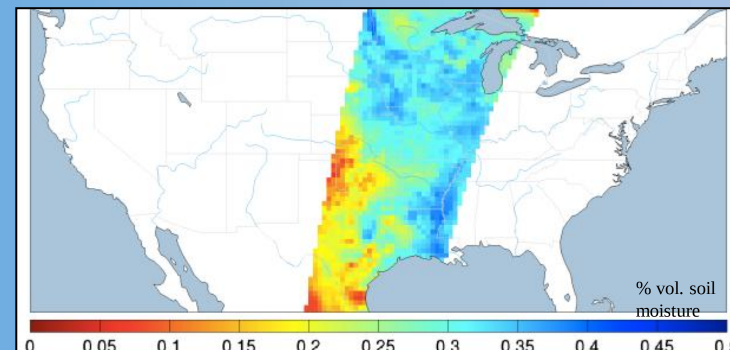
Soil Moisture Links the Global Land, Water, Energy, and Carbon Cycles

Science Returns

Current limitations:
- Installed in situ network has inadequate coverage
- Existing space-borne sensors have inadequate sensitivity & resolution

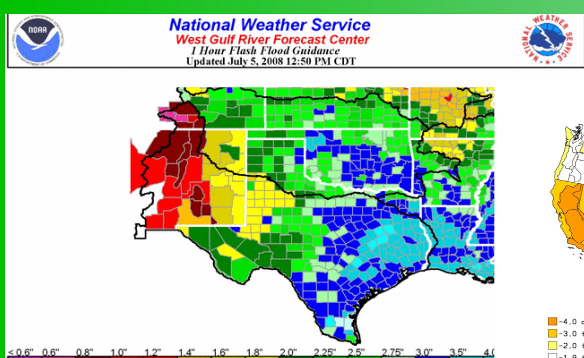


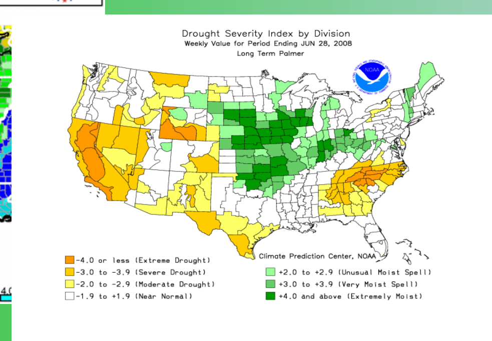
SMAP's 1000 km wide swath maps global surface soil moisture with high revisit (2-3 days)



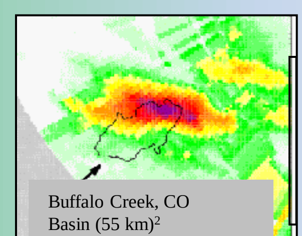
Applications Returns

Current operational flood-guidance and drought-monitoring products use model estimates of soil moisture



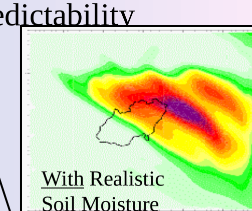


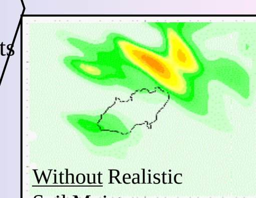
SMAP radar and radiometer allow direct estimates of surface soil moisture at an order of magnitude higher resolution resulting in enhanced predictability



Observed Rainfall
04:00Z 13/7/96

24-Hours Ahead Atmospheric Model Forecasts





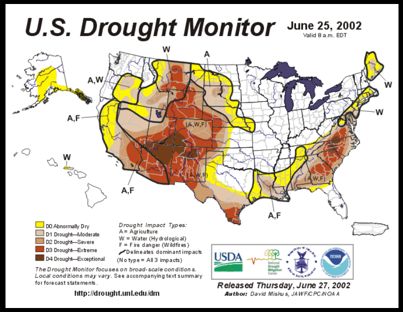
(Chen et al., *J. Atm. Sci.*, 2001)

Mapping Evapotranspiration and Drought Using Multi-Scale Thermal Remote Sensing Data

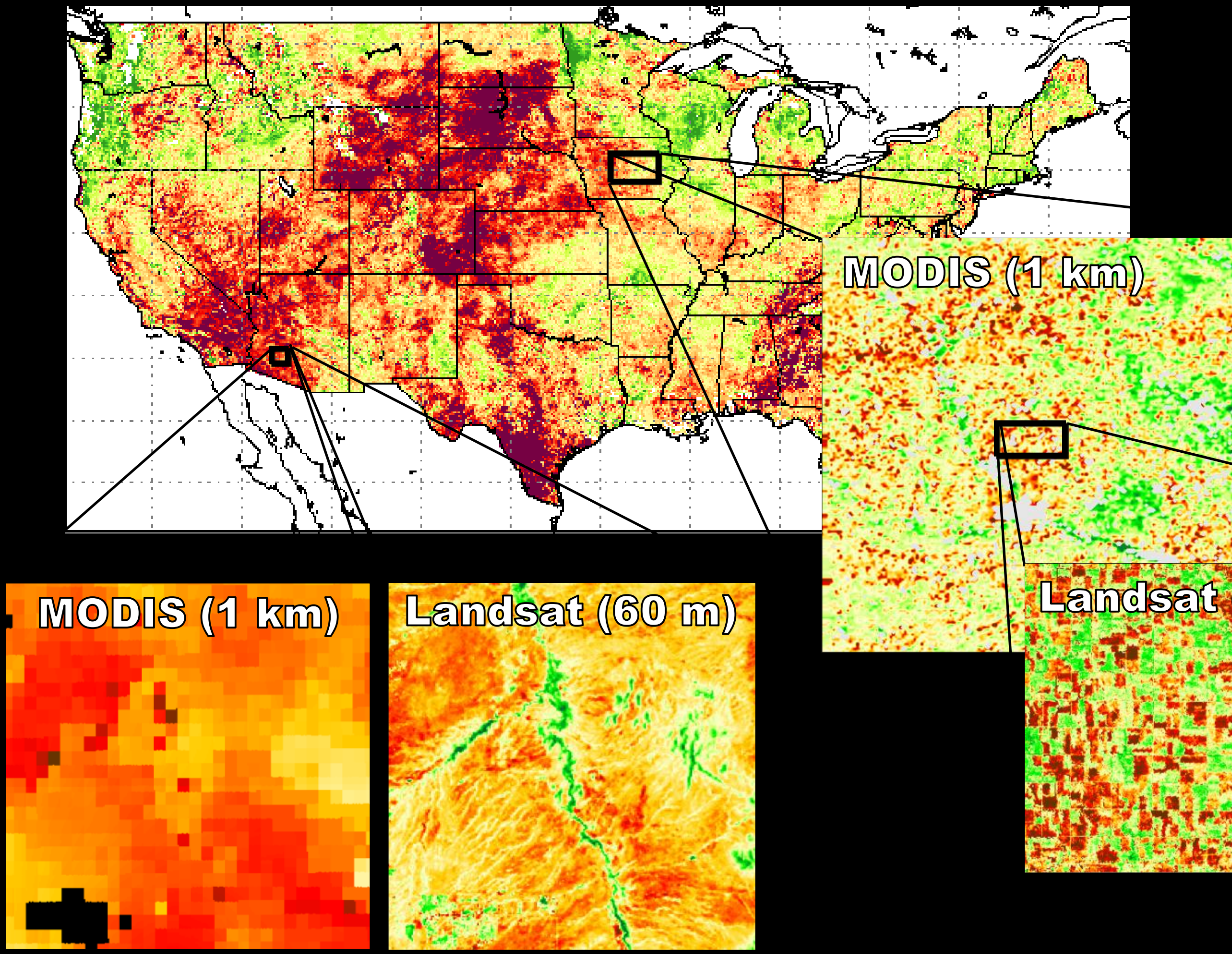
M.C. Anderson, W.P. Kustas
USDA-ARS, Hydrology and Remote Sensing Laboratory

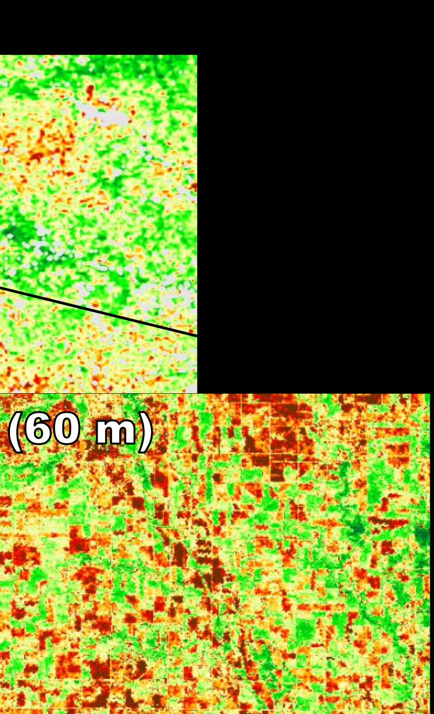
C. Hain, J.R. Mecikalski
U Alabama-Huntsville, Atmospheric Science

Multi-scale Drought Monitoring



GOES Evaporative Stress Index JUNE 2002





How's the corn looking?

The ability to monitor and assess crops with good results, in near-real time *via* remote sensing, may have finally been reached!

Thank you!

Spatial Analysis Research Section
USDA/NASS R&D Division

http://www.nass.usda.gov/research/Cropland/SARS1a.htm

Questions?