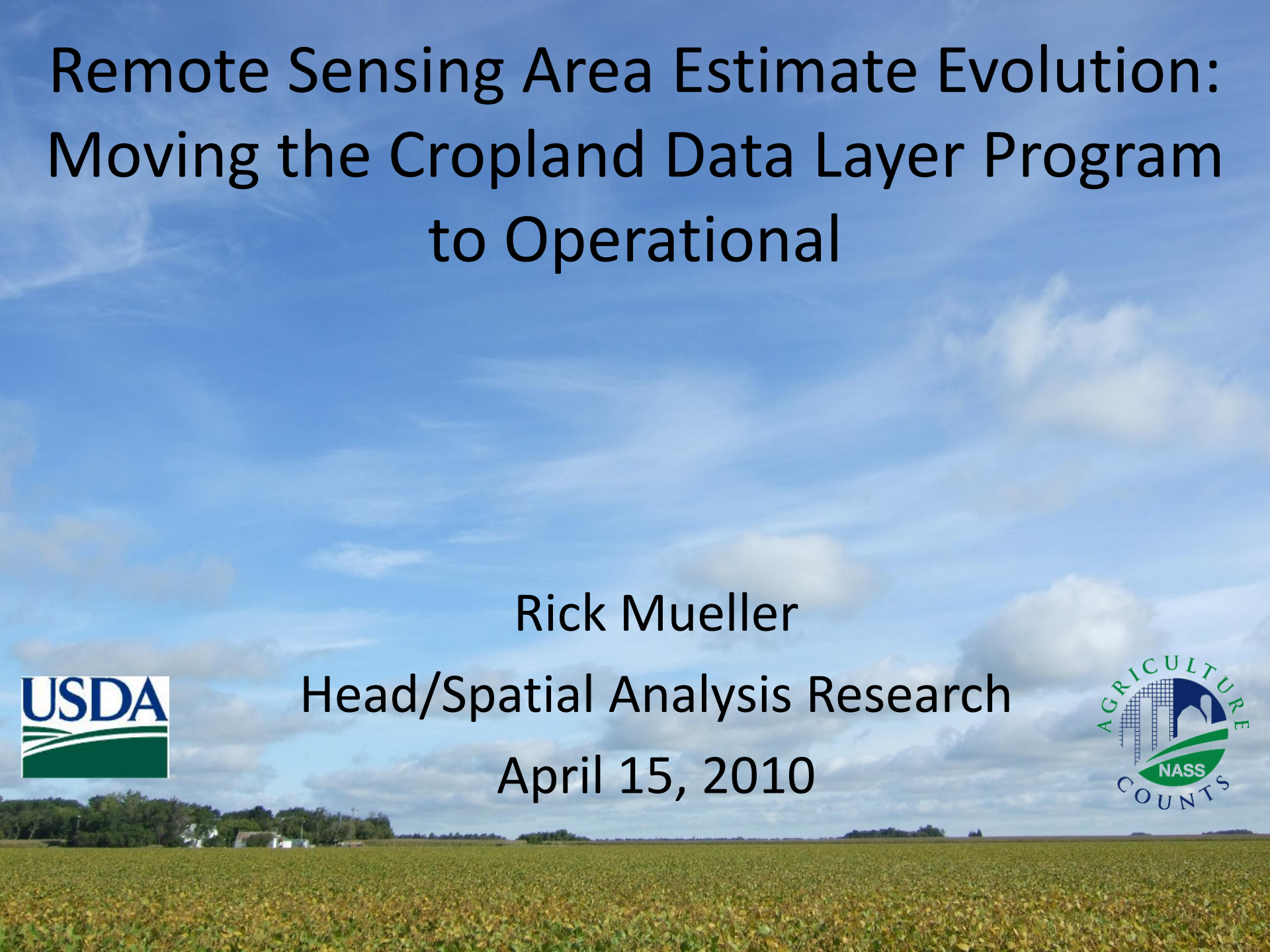
Remote Sensing Area Estimate Evolution: Moving the Cropland Data Layer Program to Operational

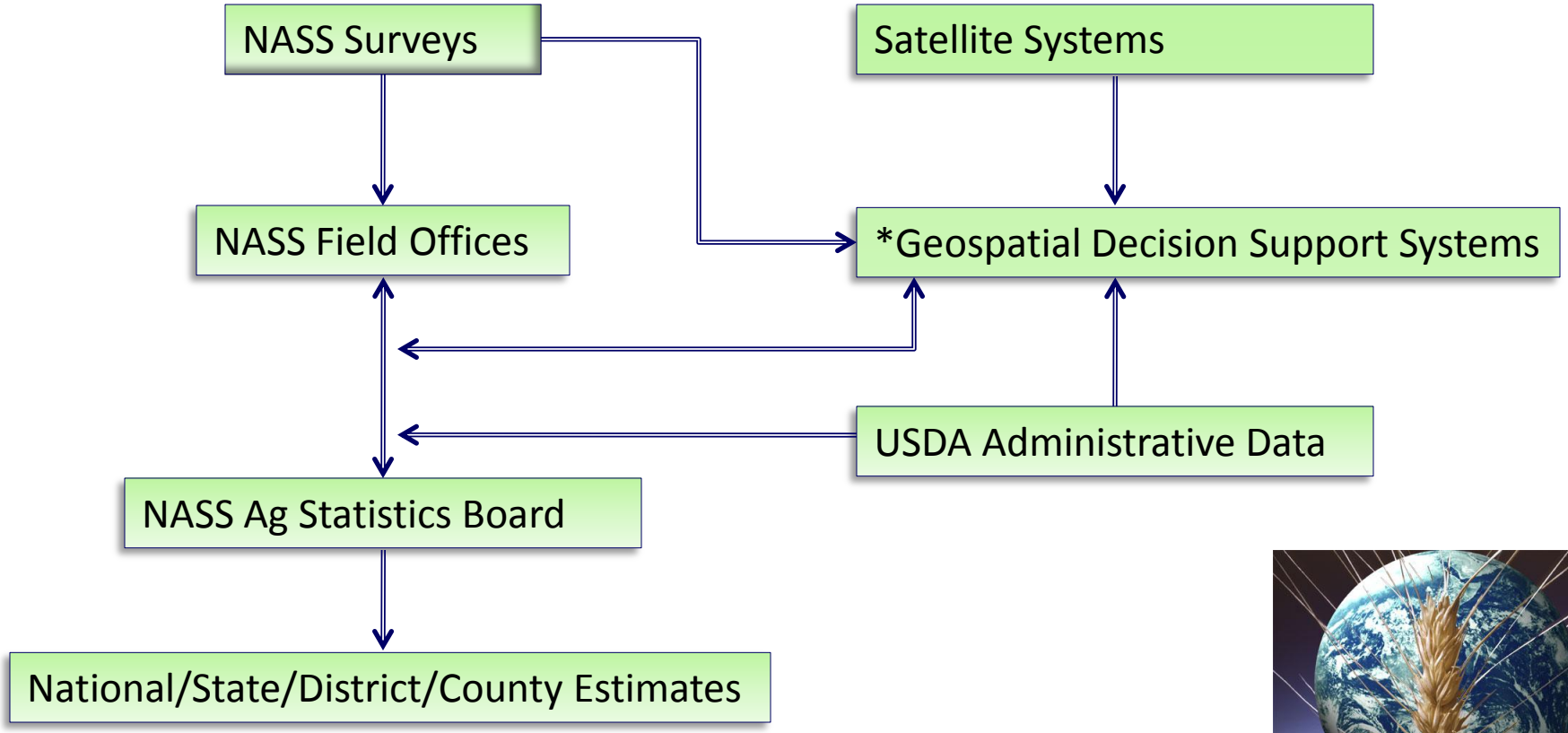
Rick Mueller

Head/Spatial Analysis Research

April 15, 2010

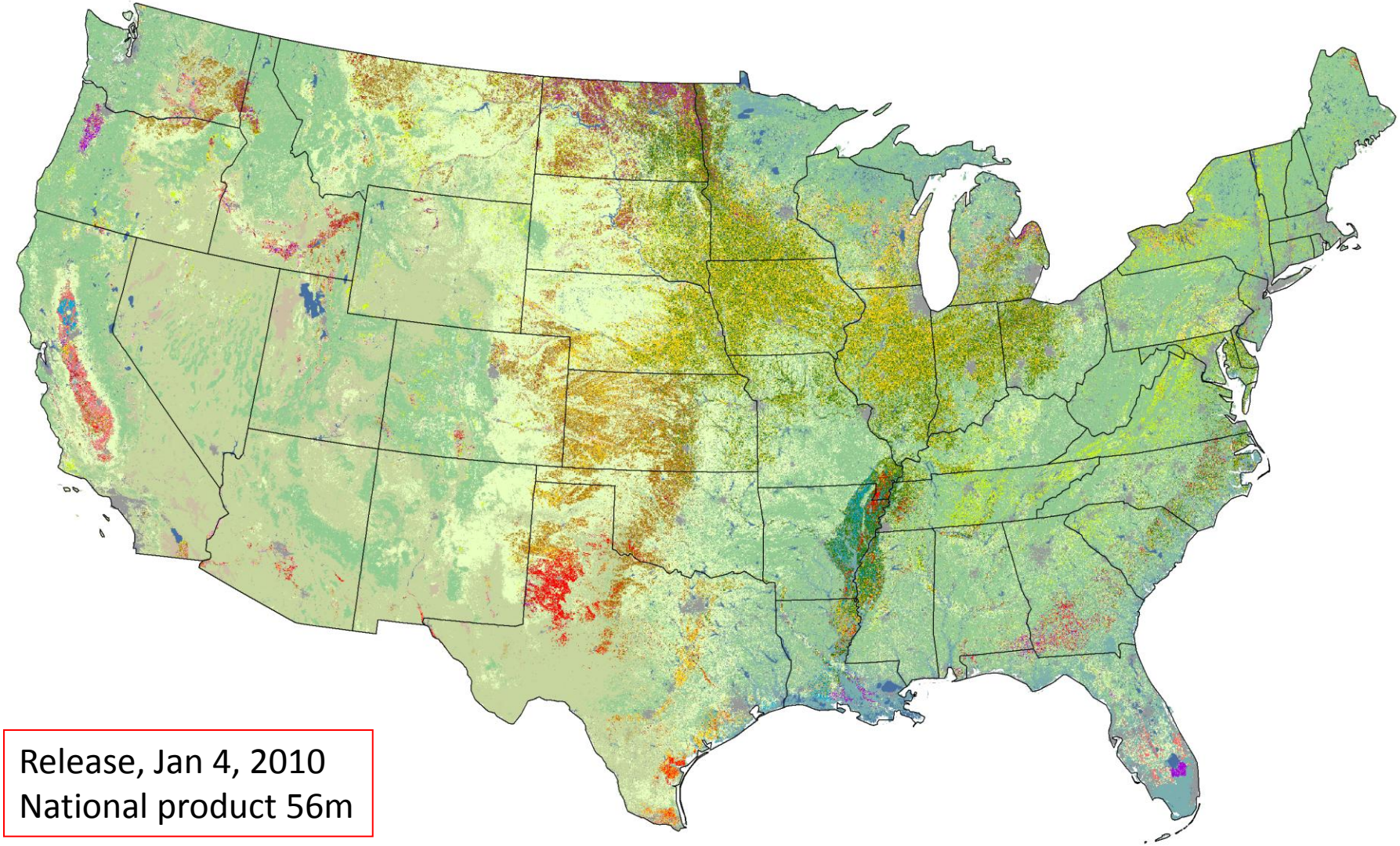


NASS Estimation Systems



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

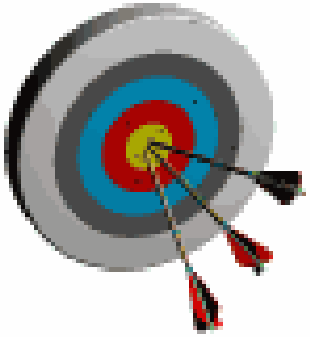
2009 Cropland Data Layers



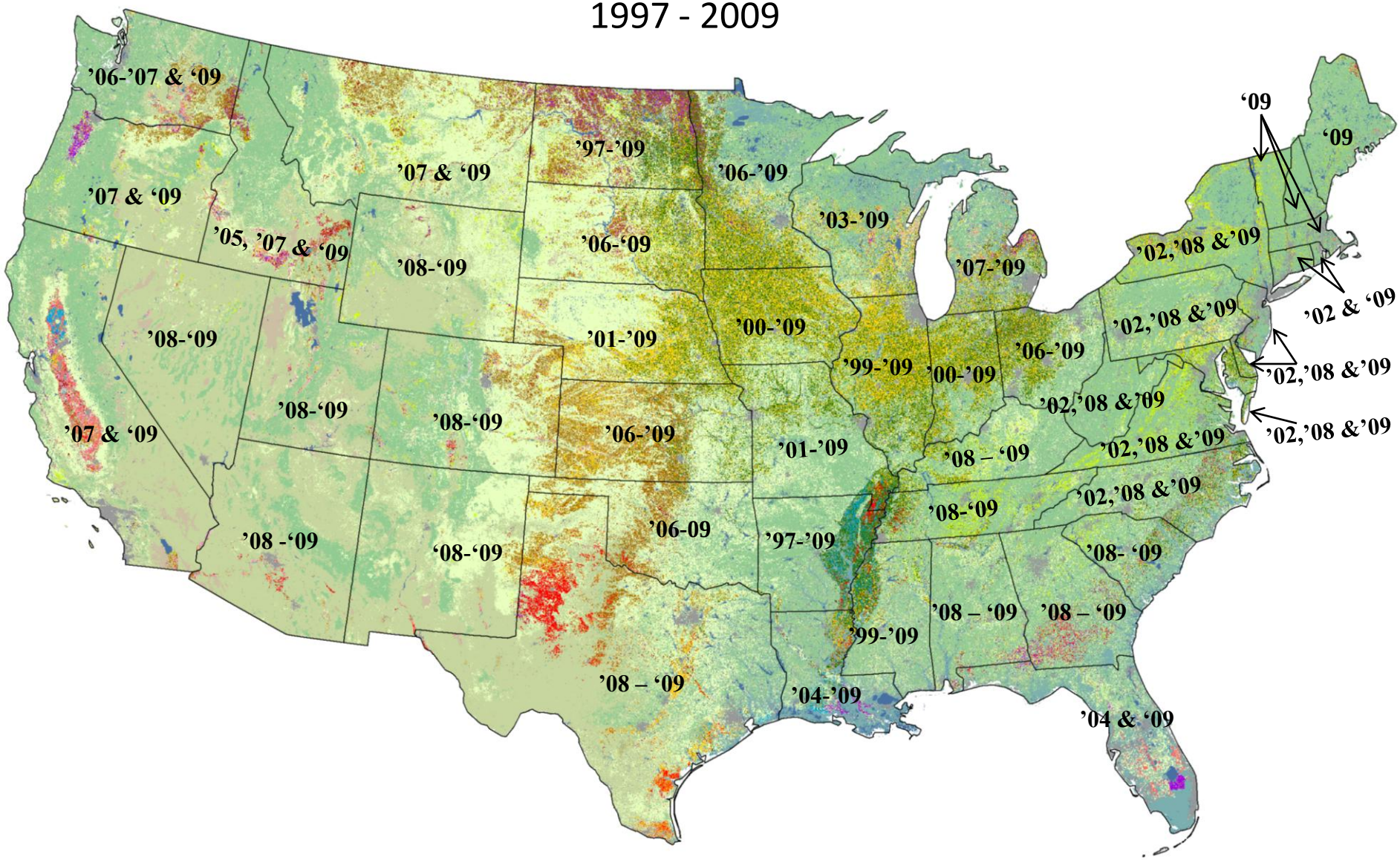
Release, Jan 4, 2010
National product 56m

Cropland Data Layer (CDL) Objectives

- "Census by Satellite"
  - *Annually* cover major program crops and regions
  - Crops accurately geo-located
- Deliver in-season remote sensing acreage estimates
  - NASS Official Reports
  - Update planted area
  - Reduce respondent burden
- Provide timely, accurate, useful estimates
  - Measurable error
  - Unbiased/independent estimator
  - State, District, County
- Public domain crop specific crop classification
  - Hosted @ NRCS Geospatial Data Gateway or http://www.nass.usda.gov/research/Cropland/SARS1a.htm or
  - Google "Cropland Data Layer"

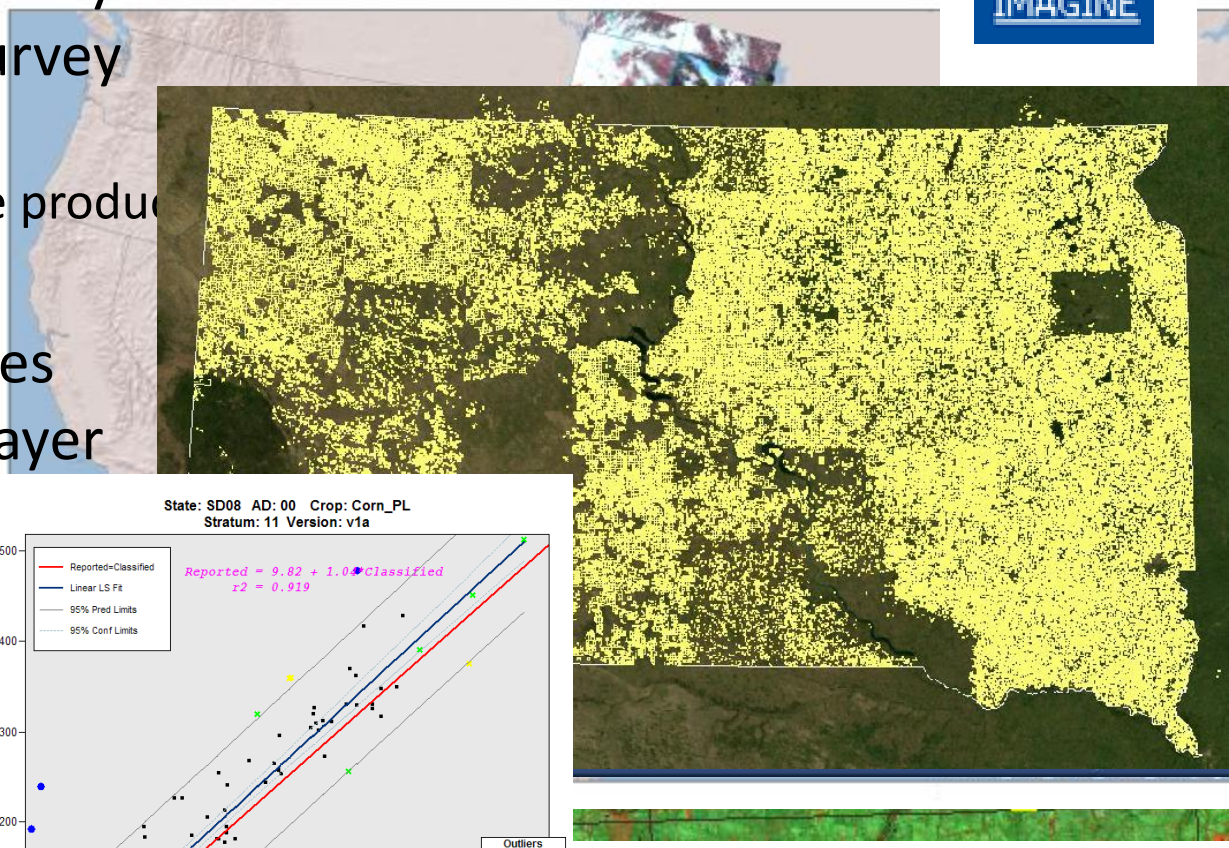


Cropland Data Layers
1997 - 2009



CDL Program

- Inputs
  - Resourcesat-1 AWiFS imagery
  - Farm Service Agency – Common Land Unit
  - NASS June Ag Survey
  - Ancillary data
    - NLCD & derivative produ
- Outputs
  - Acreage Estimates
  - Cropland Data Layer
- Process
  - Commercial so



CDL Production Schedule

Crop Production Report
CDL Corn & Soybeans

Ad-Hoc July Crop Production Report

Crop Production Report
CDL All Crops

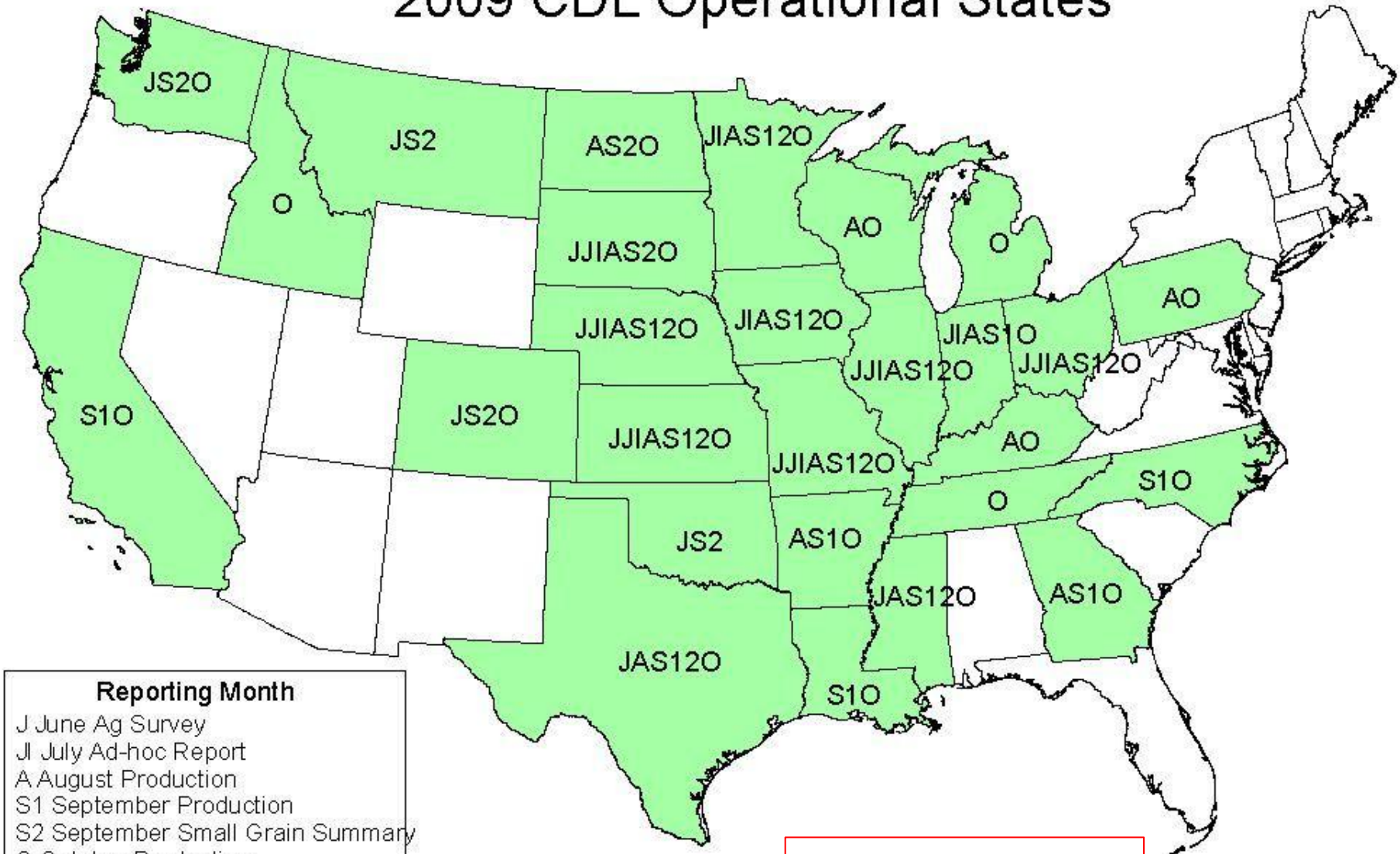
Acreage Report
CDL Winter Wheat

Crop Production Report
CDL Cotton & Rice & Peanuts

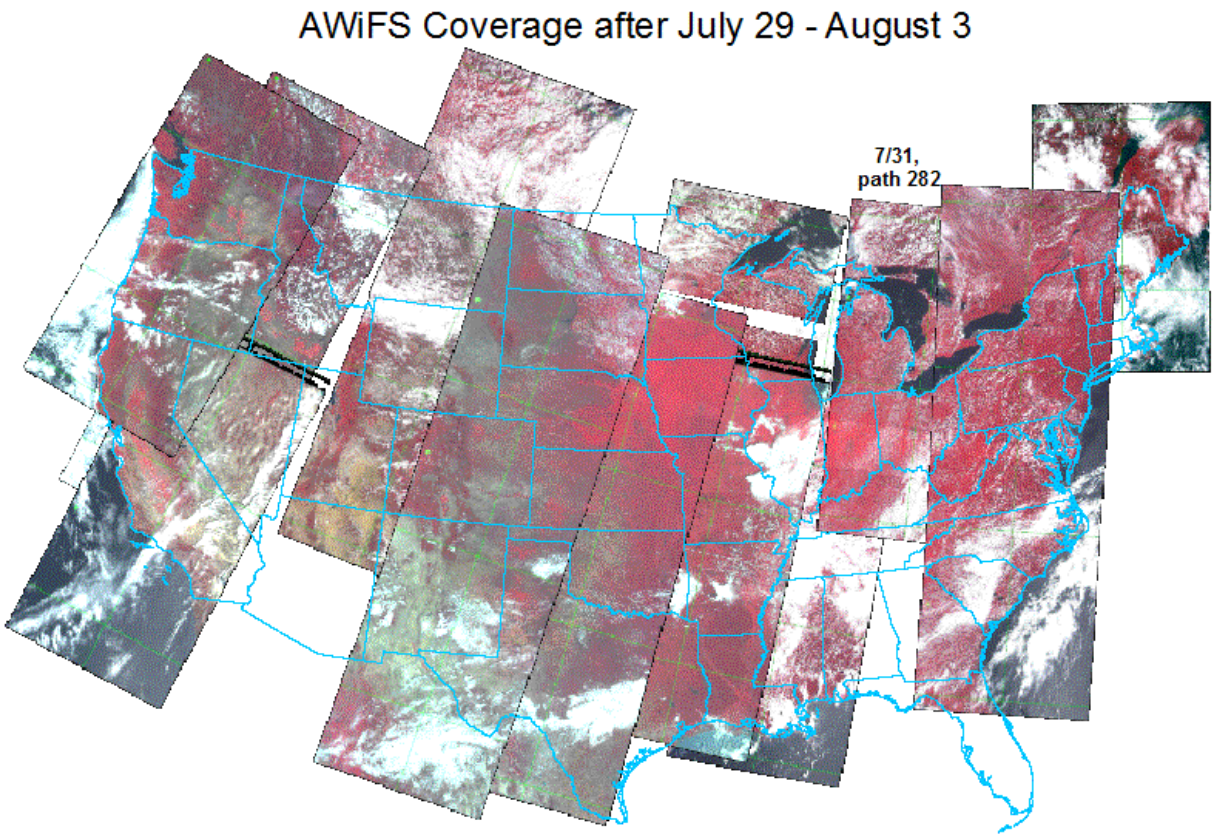
Small Grains Summary
CDL Small grains

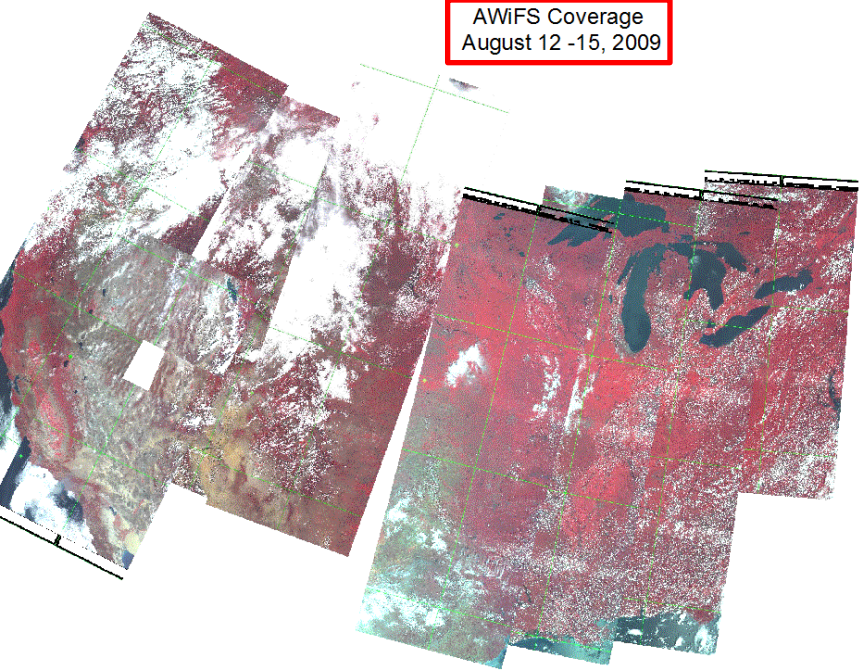
Historically only 1 CDL per state produced:
Crop Production Annual Summary
CDL all crops/county estimates

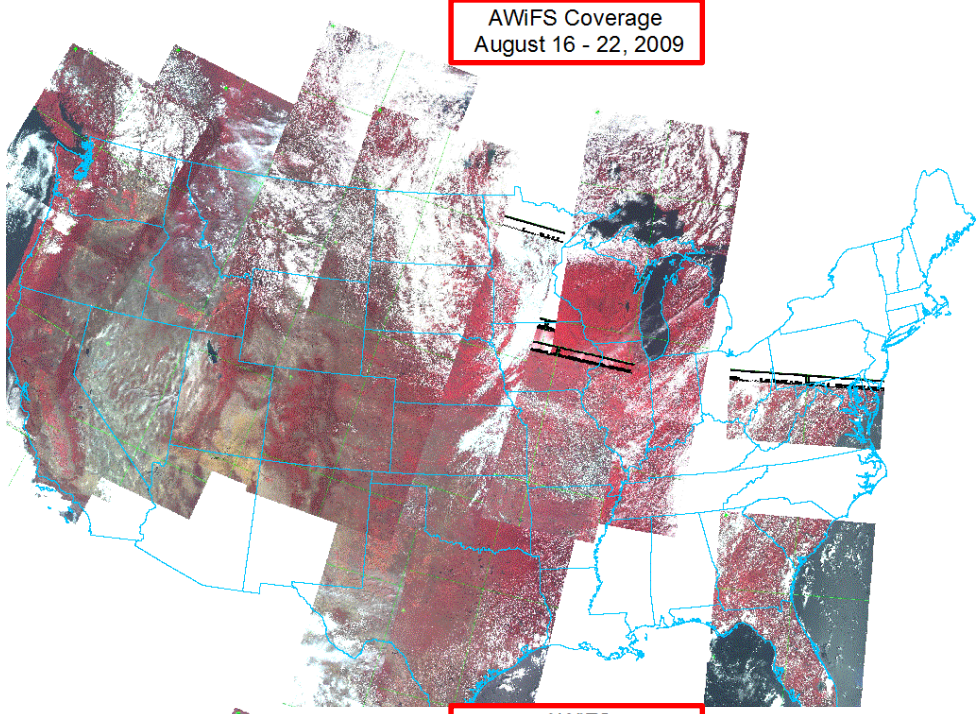
2009 CDL Operational States

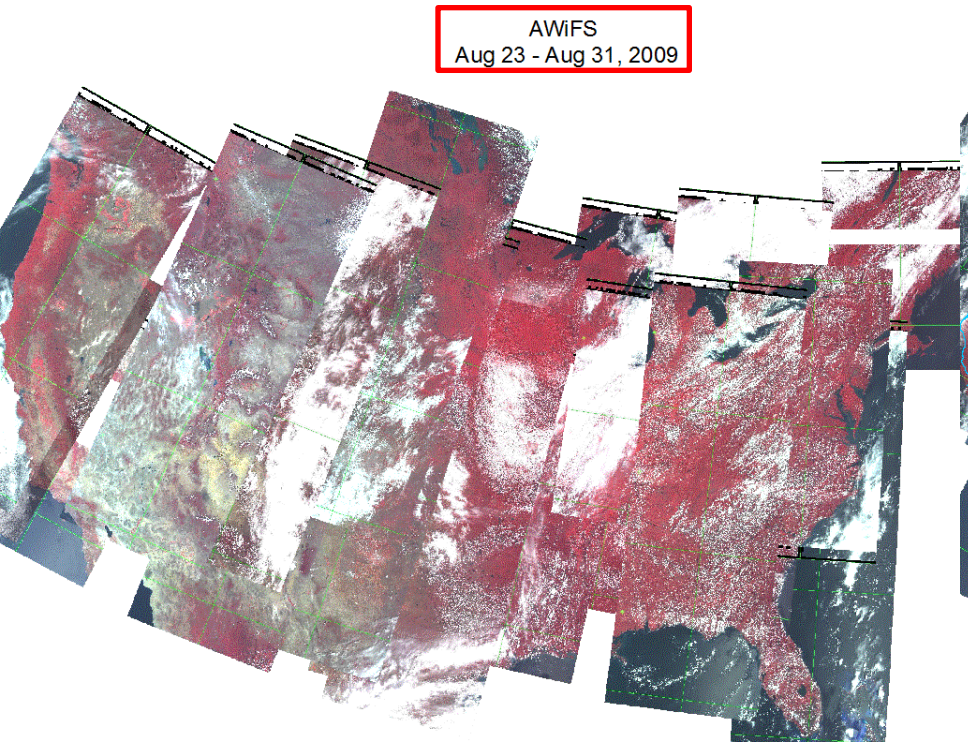


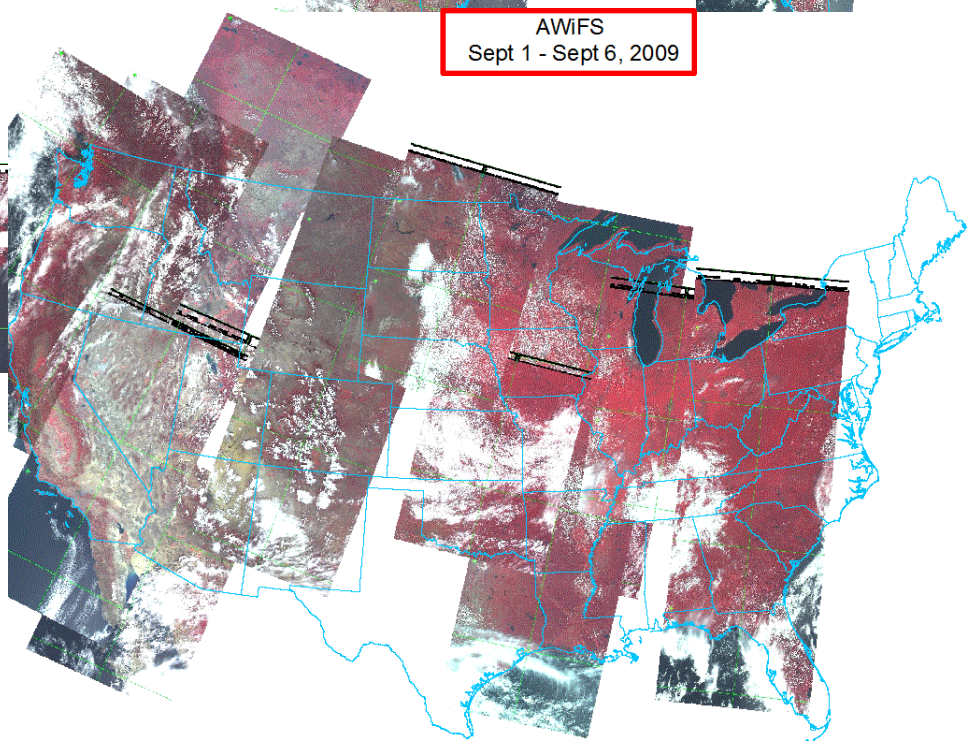
AWiFS Mid-Summer Acquisitions



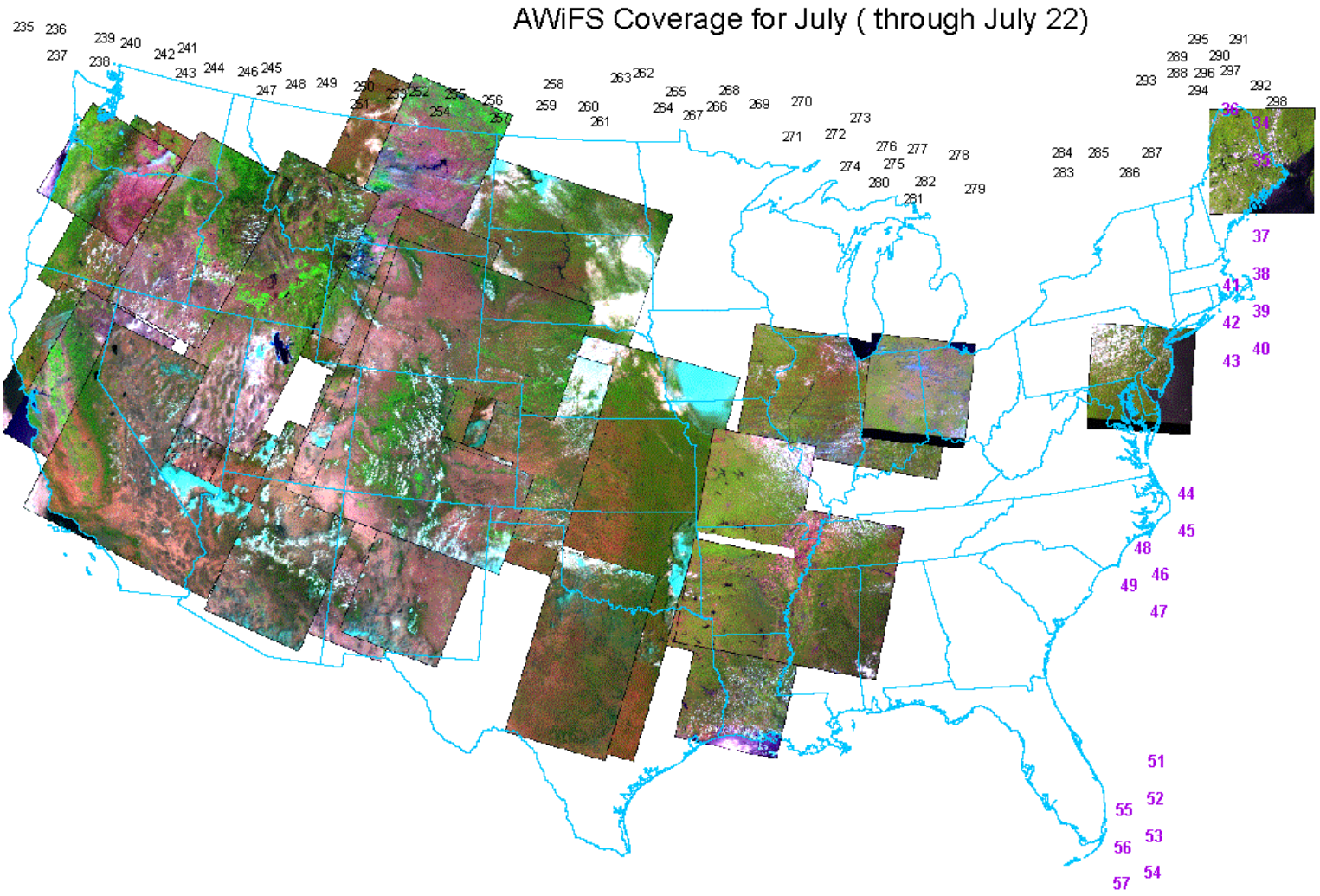

AWiFS Coverage
August 12 -15, 2009

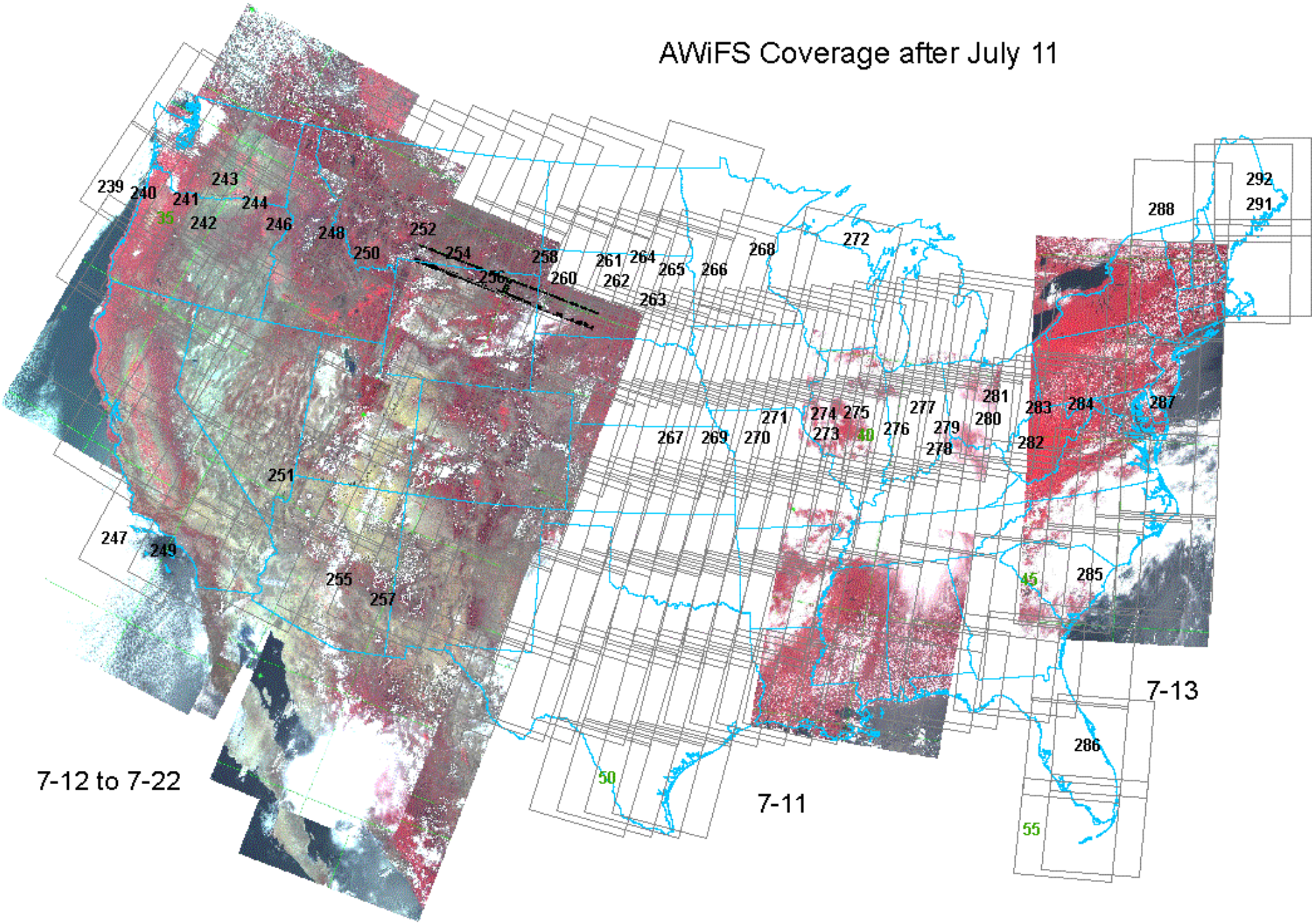

AWiFS Coverage
August 16 - 22, 2009


AWiFS
Aug 23 - Aug 31, 2009


AWiFS
Sept 1 - Sept 6, 2009

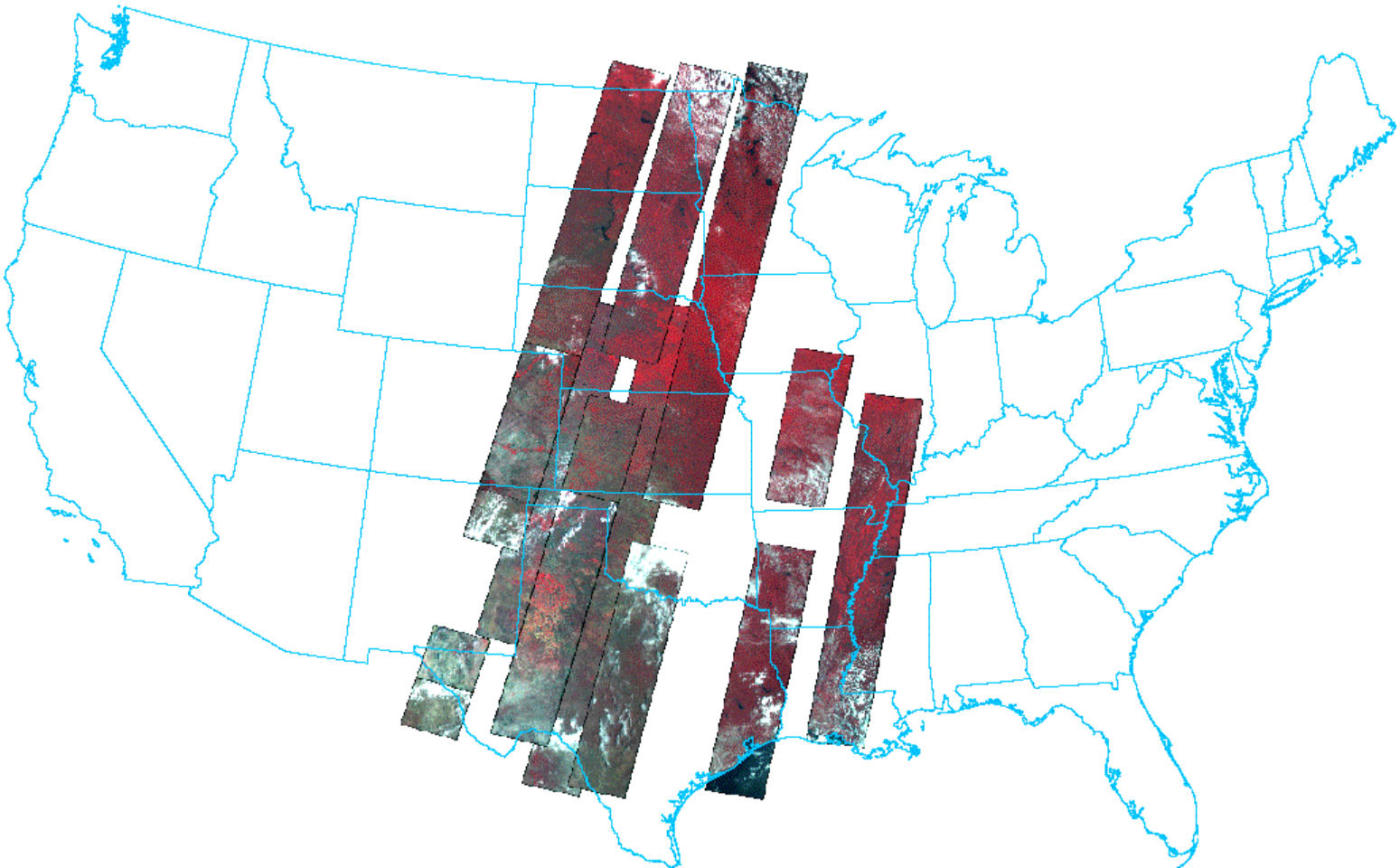
July AWiFS Collection Drought




AWiFS Coverage after July 11
239
240
241
243
244
35
242
246
248
250
252
254
256
258
260
261
262
263
264
265
266
268
272
288
292
291
267
269
270
271
273
274
275
40
276
277
278
279
280
281
282
283
284
287
251
247
249
255
257
45
285
286
50
55
7-13
7-11
7-12 to 7-22

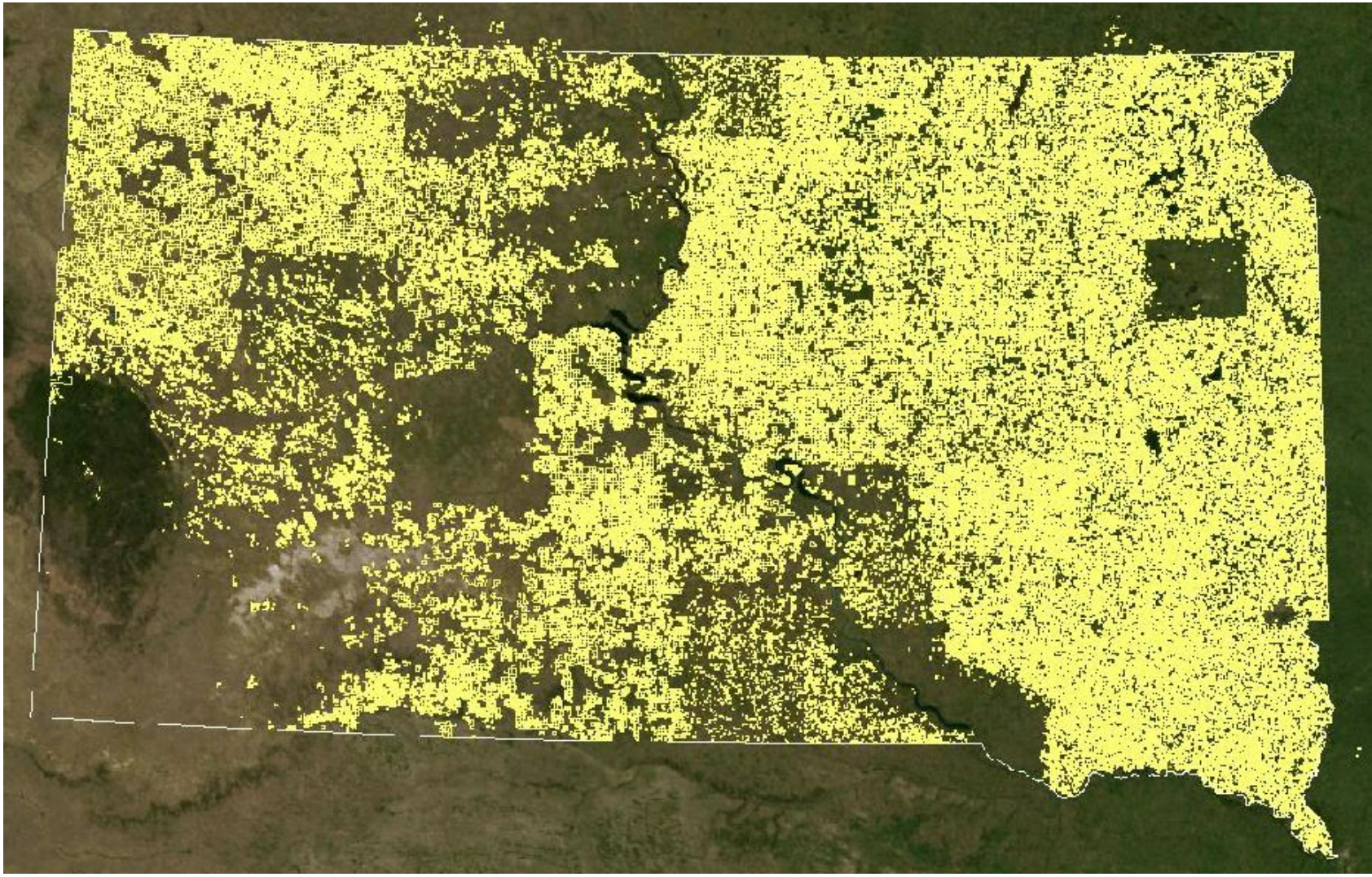
Landsat to the Rescue

Landsat Coverage
downloaded August 18, 2009



Agricultural Ground Truth
FSA Common Land Unit

USDA United States Department of Agriculture
Farm Service Agency



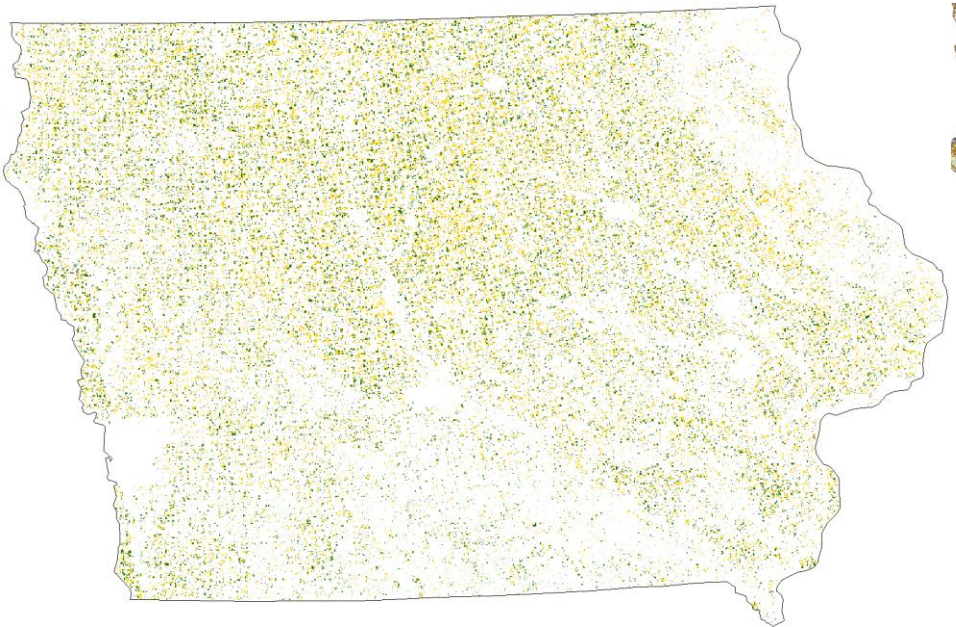
Ground Truth – Land Cover

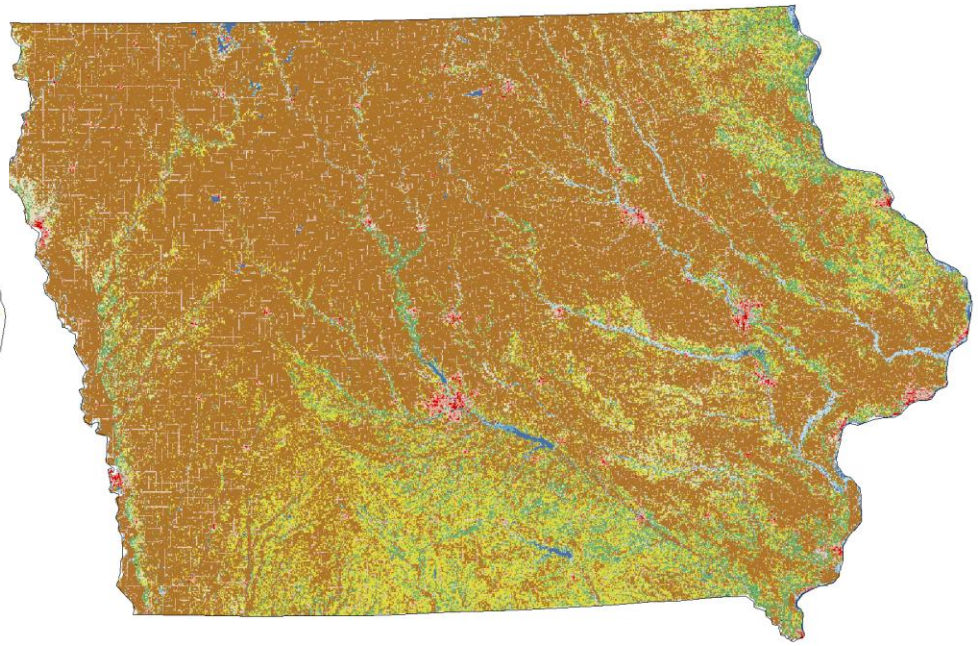
Agricultural Ground Truth

- Provided by FSA
- Id's known fields and crops
- Divide known fields into 2 sets
  - ½ used for training software
  - ½ used for validating results

Non-Agricultural Ground Truth

- USGS National Land Cover Dataset
- Identifies urban infrastructure and non-agriculture land cover
  - Forest, grass, water, cities

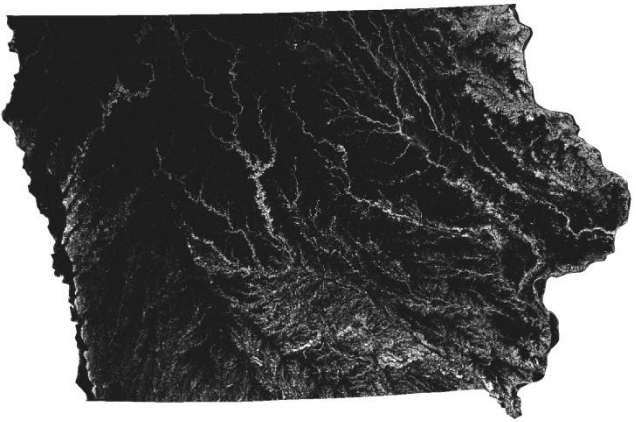




Ground Truth – Ancillary

US Geological Survey

Forest Canopy

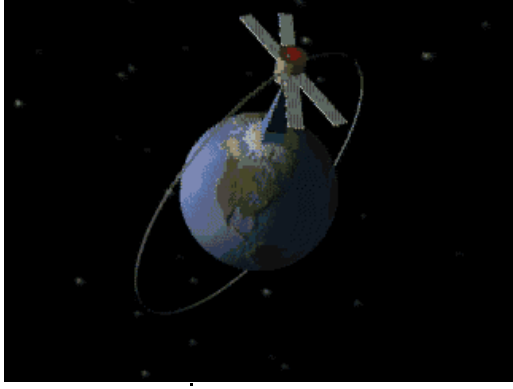


Elevation

Impervious Surfaces

Ancillary datasets help separate the agricultural landscape; determining agricultural potential

Data Partnerships



- Foreign Agricultural Service
  - Resourcesat-1 AWiFS

Linking U.S. Agriculture to the World FAS

- Farm Service Agency
  - Common Land Unit “ground truth”

USDA Farm Service Agency

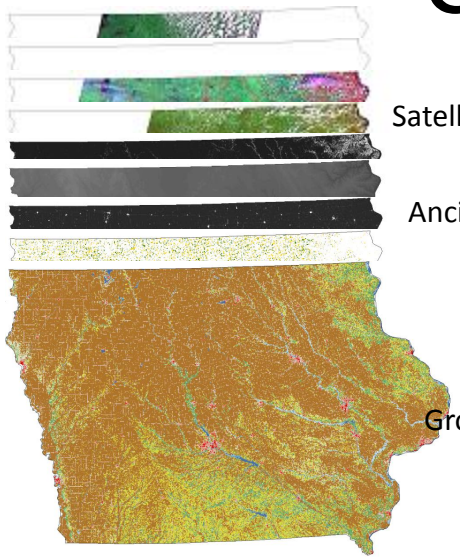
- US Geological Survey
  - National Land Cover Dataset

MRLC Consortium

- US Geological Survey/ NASA
  - Landsat TM 5 & 7
  - MODIS

USGS science for a changing world NASA

CDL Processing Method



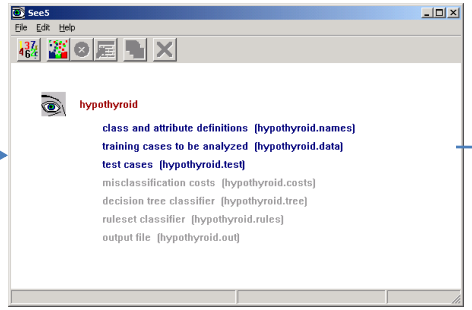
Satellite Imagery

Ancillary Data

Ground Truth

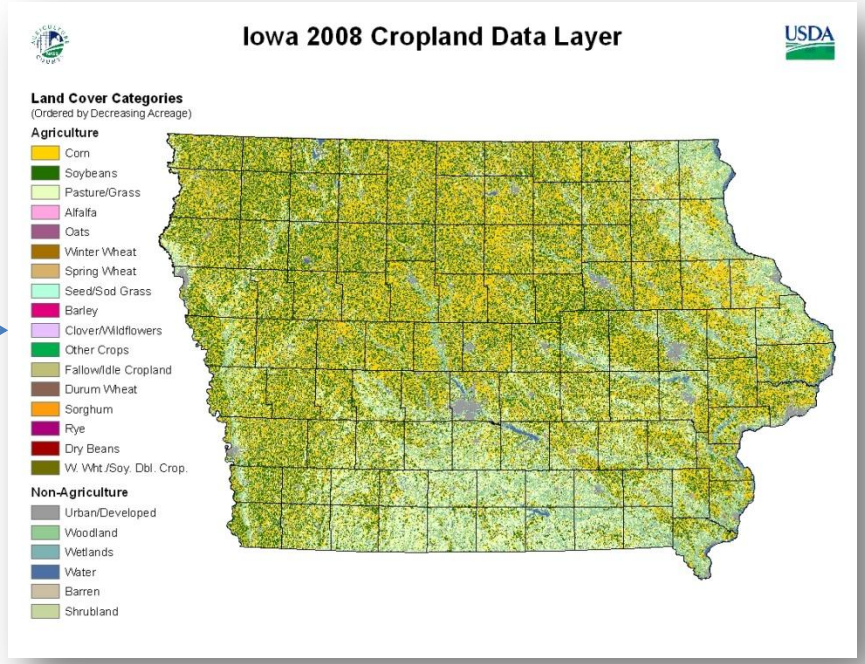
Sampling Done by

See5



Decision Tree

Classification

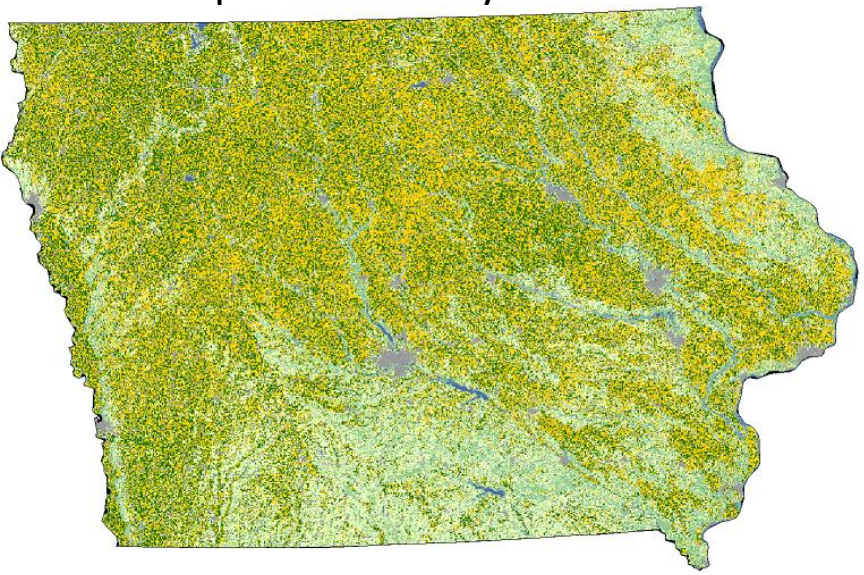


Validating CDLs

Measures CDL Accuracy

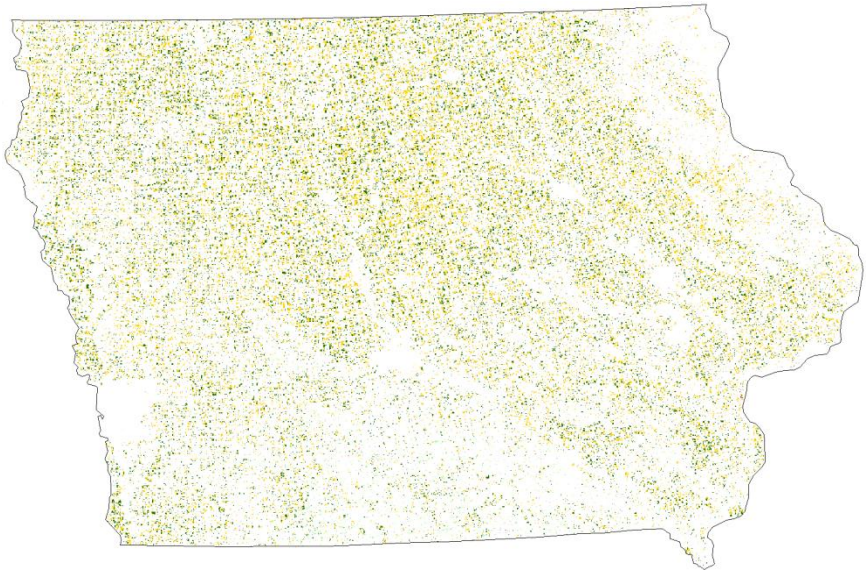
- Compare
  - Classified pixels from CDL
  - Known pixels, not used for classifying imagery, from FSA
- Track
  - Producer Accuracy & Errors of Omission - % of pixels from CDL that match groundtruth
  - User Accuracy & Errors of Commission - % of pixels from CDL that don't match groundtruth

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.

Regression-based Acreage Estimator

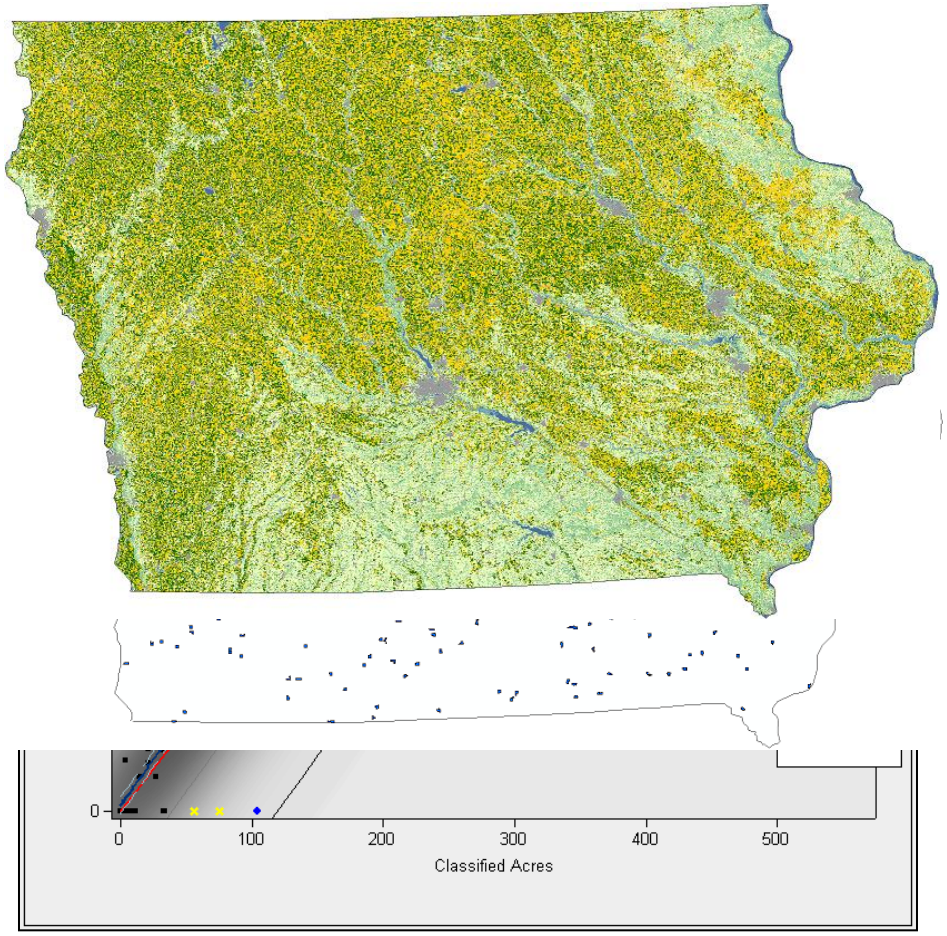
Simple Linear Regression

Regression used to relate categorized pixel counts to the ground reference data

- **(X) – Cropland Data Layer (CDL) classified acres**
- **(Y) – June Agricultural Survey (JAS) reported acres**

Outlier segment detection - removal from regression analysis

Using regression results in estimates reduces error rates over using JAS alone



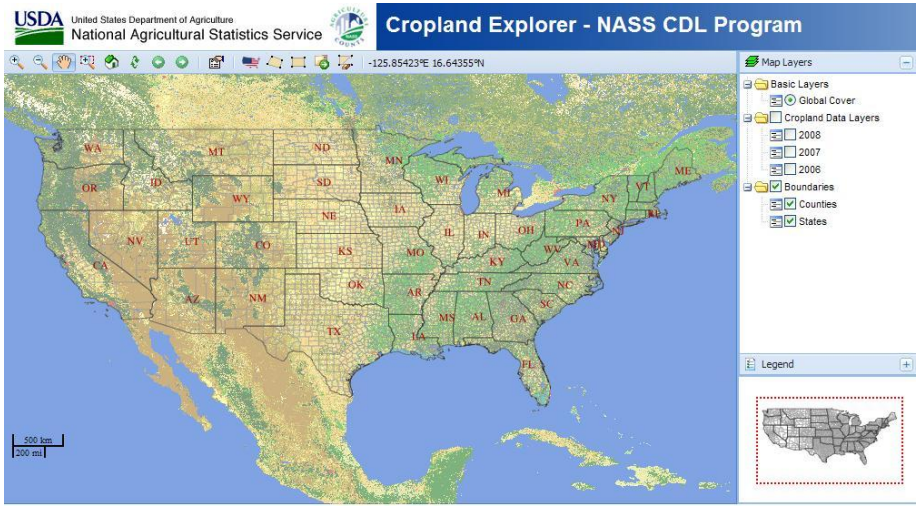
Acreage not just about counting pixels

CDL Satellite Future

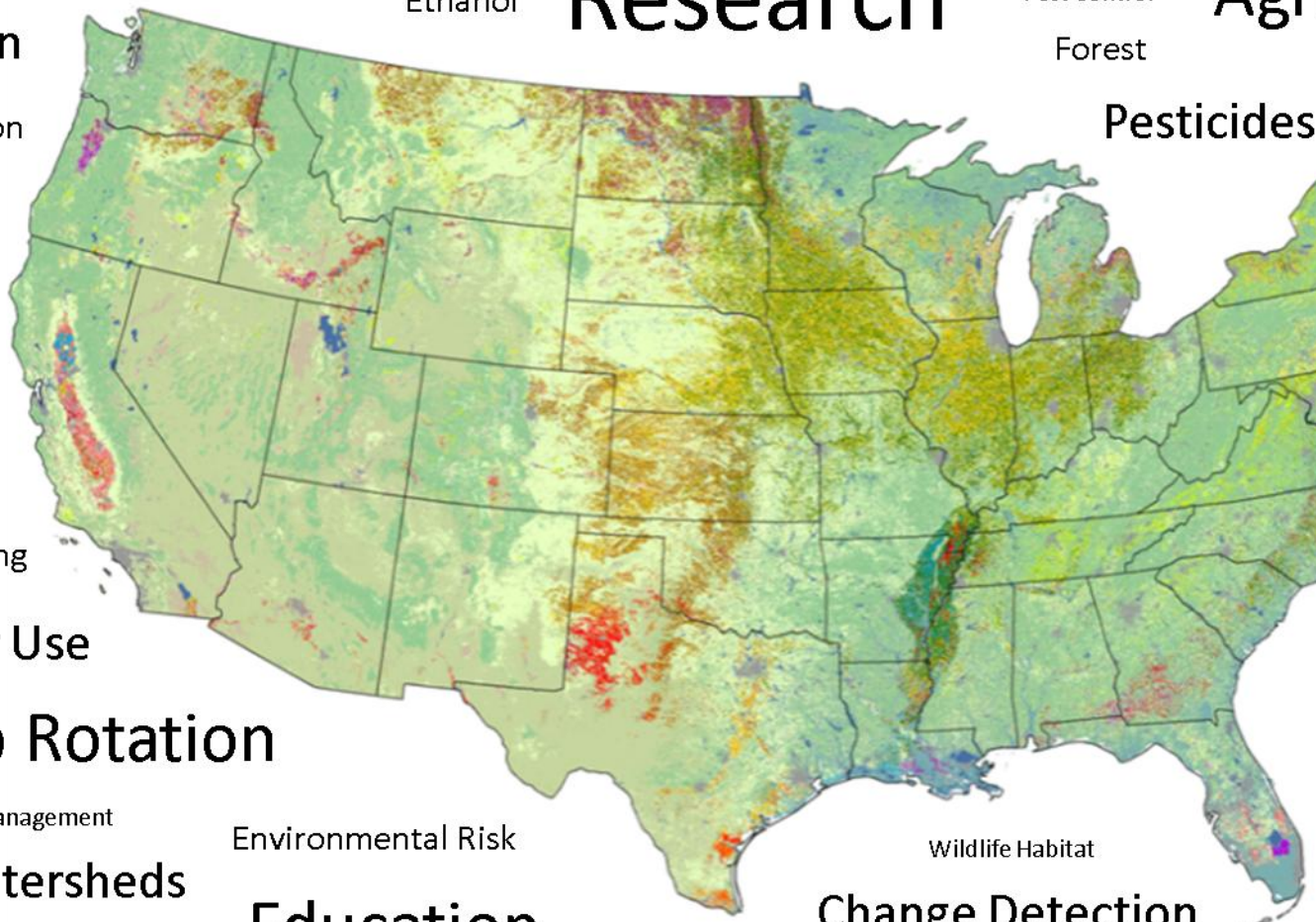
- Aging satellite fleet
  - Landsat 5 (1984)
  - Landsat 7 SLC-off (1999)
  - Indian Resourcesat-1/AWiFS (2003)
- Future
  - Resourcesat-2 (operational ~late 2010)
  - Landsat Data Continuity Mission (LDCM) ~2013
  - French Spot 4/5

CDL Future

- National CDL crop year 2009
  - Funded in part by EPA released Jan 2010
- Fund Geospatial CDL portal
  - George Mason U/Center for Spatial Information Science and Systems
- National Commodity Crop Productivity Index
  - NRCS dynamic soils layer



NASS Cropland Data Layer Applications



Climate
Acreage Estimates
Irrigation
Land Cover
Soil Utilization
Modeling
Epidemiology
Ethanol
Research
Pest Control
Agribusiness
Carbon
Forest
Biodiesel
Erosion
Pesticides
Ecology
Fertilizer
Yield
Biofuel
CRP
Land Use
Ecosystem
Commodity
Planning
Urban Growth
Water Use
Soil and Water
Crop Rotation
Fertilizer Usage
Crop Intensity
Land Management
Environmental Risk
Wildlife Habitat
Watersheds
Water Quality
Education
Change Detection
Mapping
Transportation
Data Mining
Condition Assessment
Disaster Assessment
Crop Production
Crop Protection