USDA/National Agricultural Statistics Service Geospatial Programs

Research & Development Div.
Geospatial Information Branch - Spatial Analysis Research Section (SARS)
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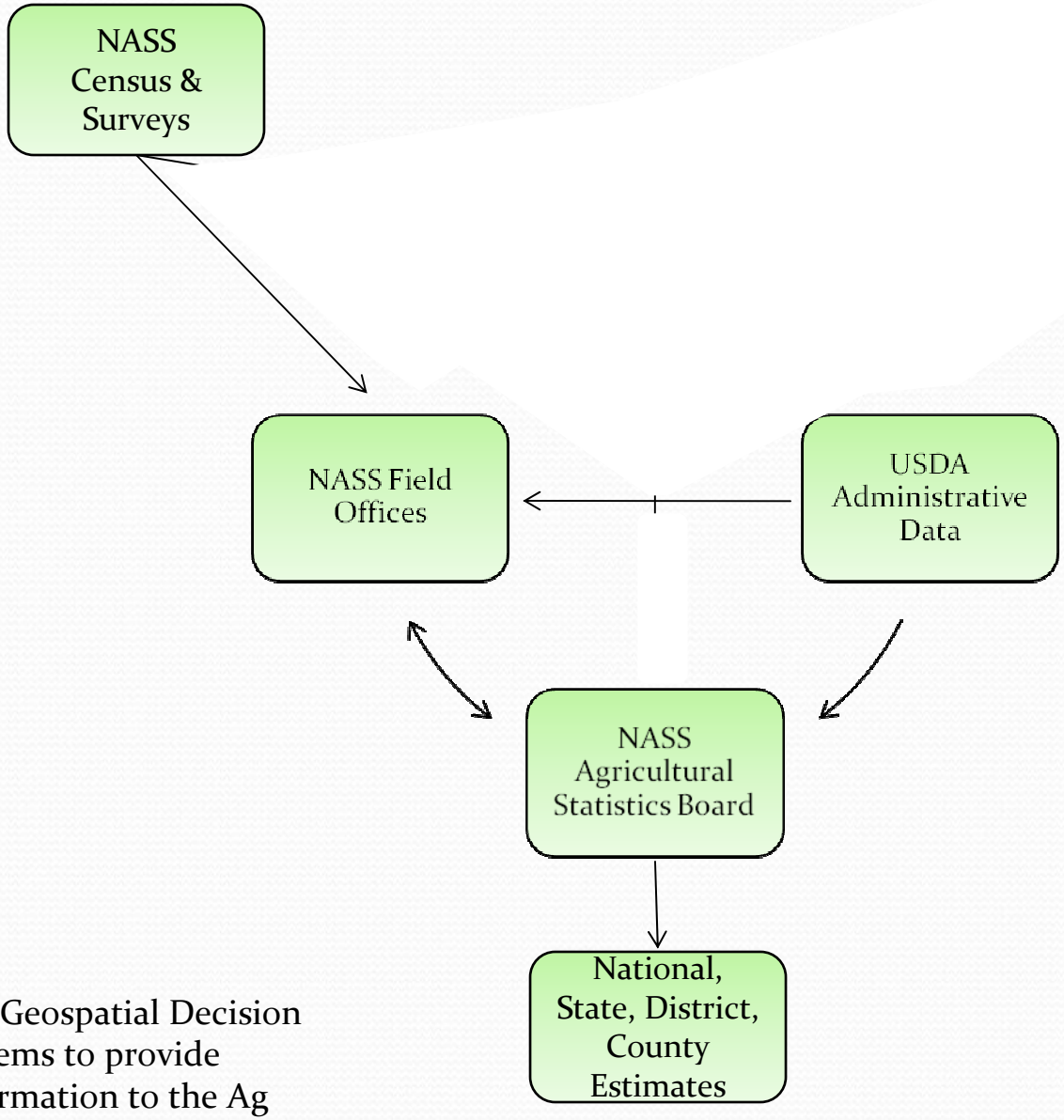
The NASS Mission

"To provide timely, accurate, and useful statistics in service to U.S. agriculture"

- U.S. statistical system is decentralized.
- The Food & Fiber Sector is largest single component of US GDP.
- NASS is the official data collection (& dissemination) arm of USDA, providing the Official Statistics of and about US Agriculture.
- Most data series mandated by law.
- Crop monitoring & assessment is mandated, but NASS works closely with the public and agriculture sector to determine report content & scheduling.
- We're a public information service, we don't do much in the way of analyses, interpretation, or predictions.
- Literally billions of $$$ and millions of decisions are made based on NASS reports every year, a heavy responsibility to "get it right".
- NASS is unique in that we are a federal, operational program, with a statistical research component, mandated by law.

My point – NASS acreage & crop reports are serious business, and the acceptance of remote sensing-based crop monitoring & assessments by the Agency is a major

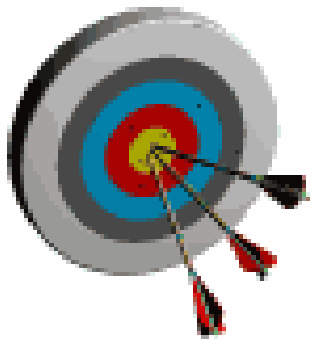
NASS Estimation Systems

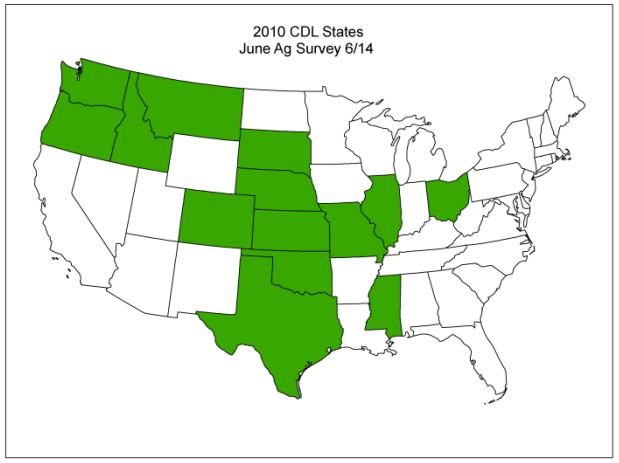


* NASS Uses Geospatial Decision Support Systems to provide updated information to the Ag Statistics Board and data users

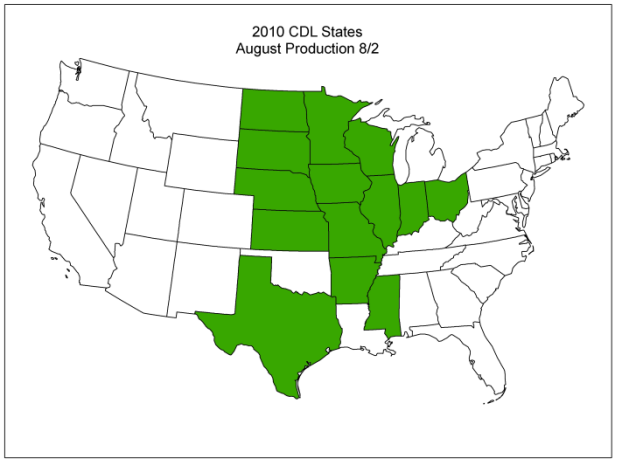
Cropland Data Layer (CDL) Objectives

- "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 from surveys
- 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"

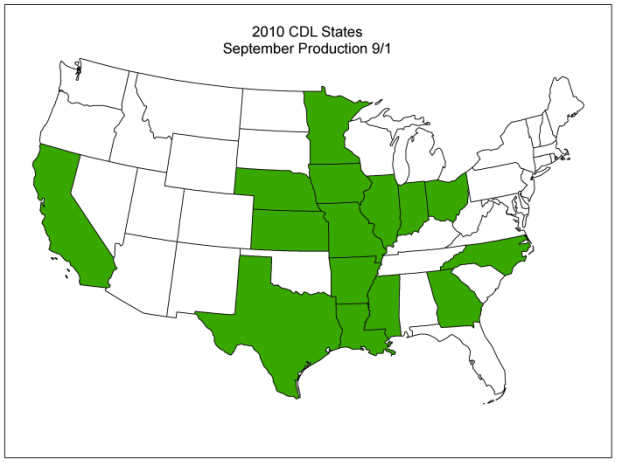




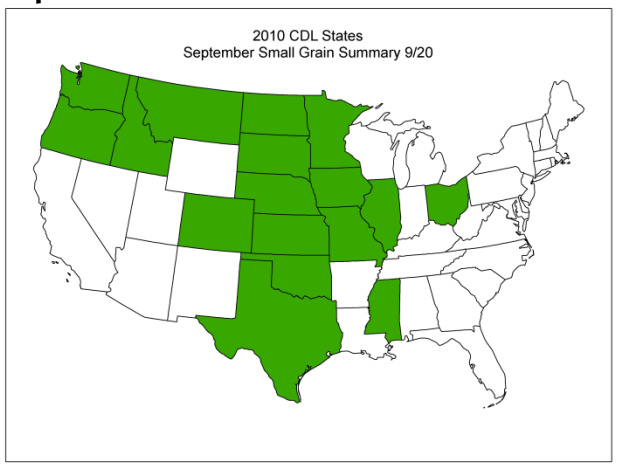
14 states – winter wheat



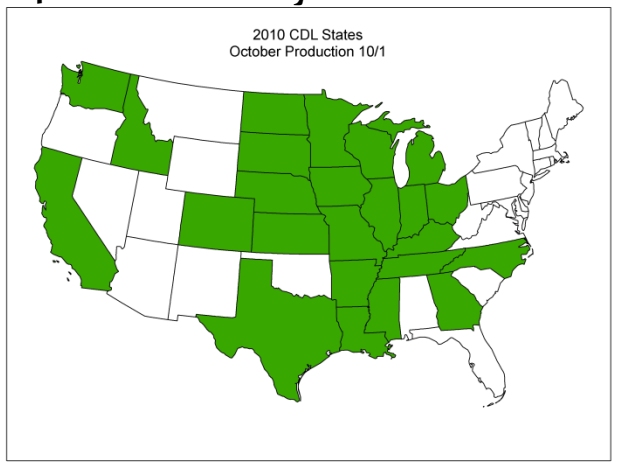
14 – corn & soybeans



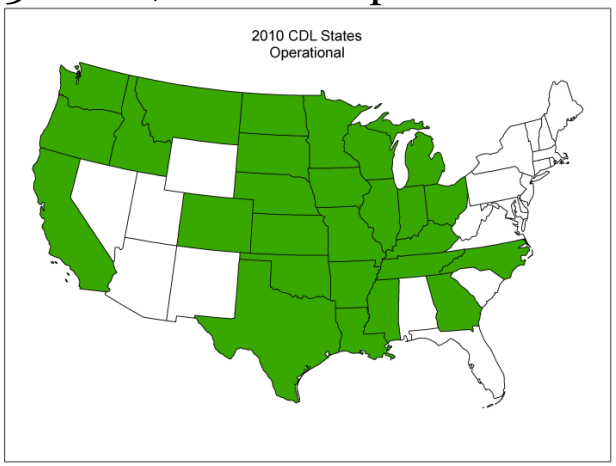
15 – rice, cotton & peanuts



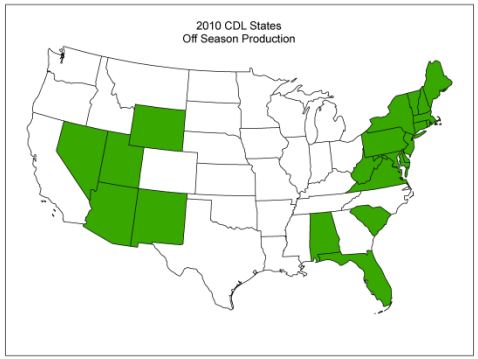
17 – all small grains



24 – all crops

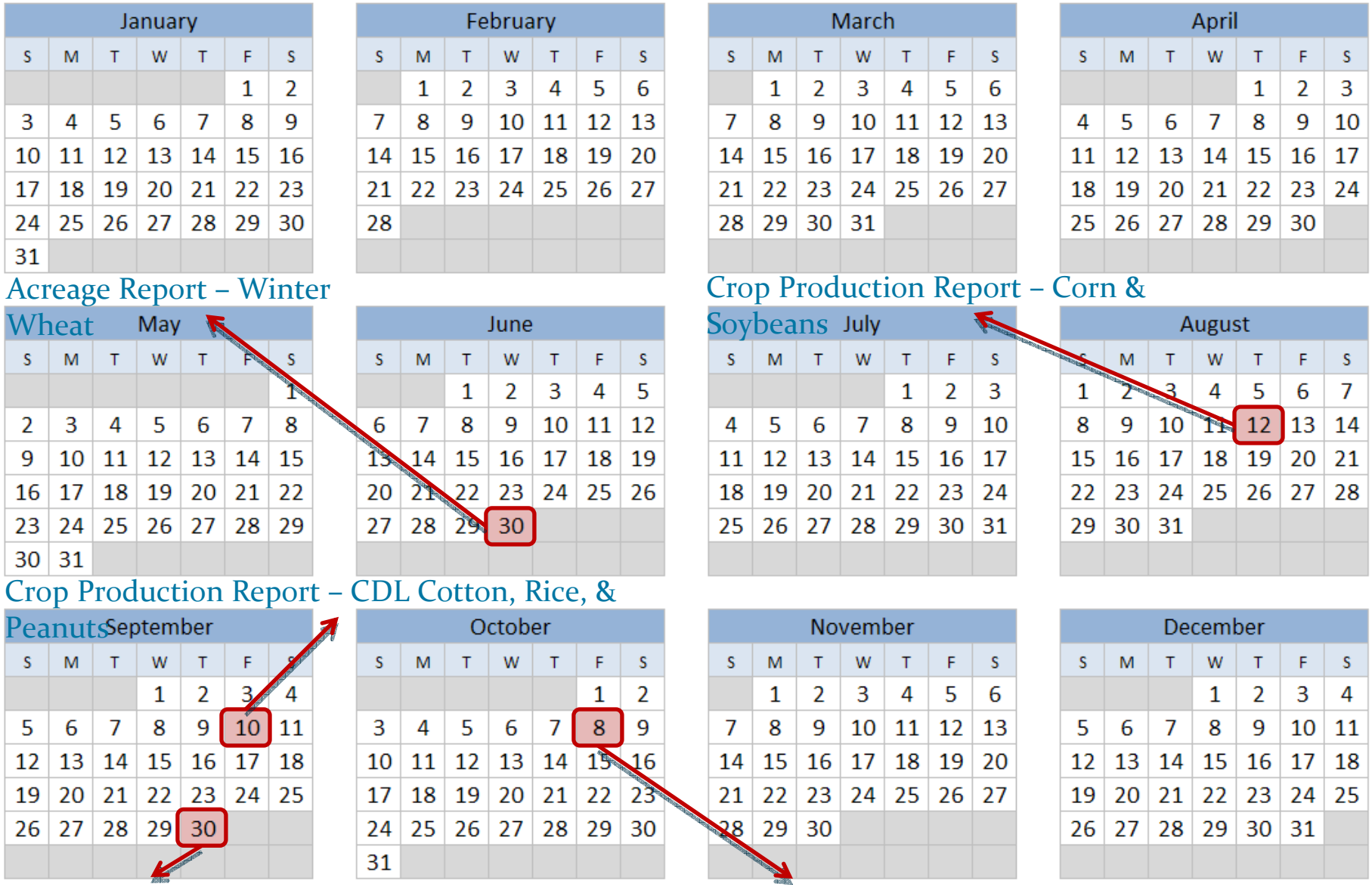


27 – operational



CDL Crop Year 2010 Plans

2010 CDL Production Schedule



Data Partnerships

Foreign Agricultural Service

Resourcesat-1 AWiFS

Farm Service Agency

Common Land Unit “ground truth”

US Geological Survey

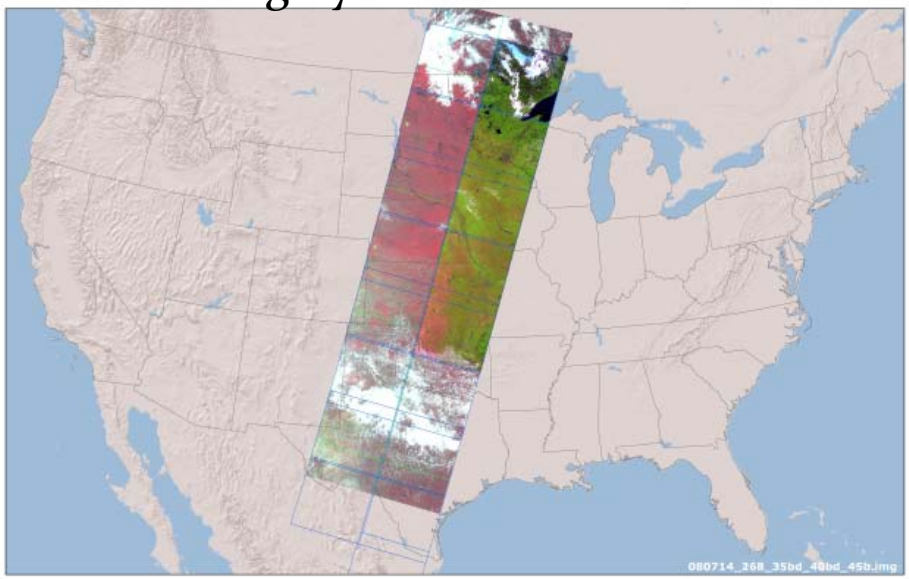
National Land Cover Dataset

US Geological Survey/ NASA

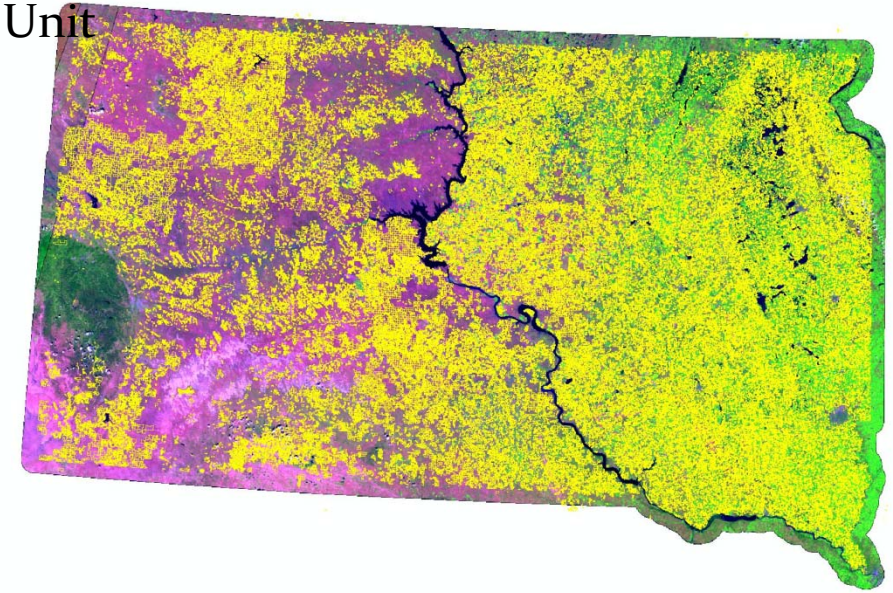
Landsat TM 5

Data Inputs

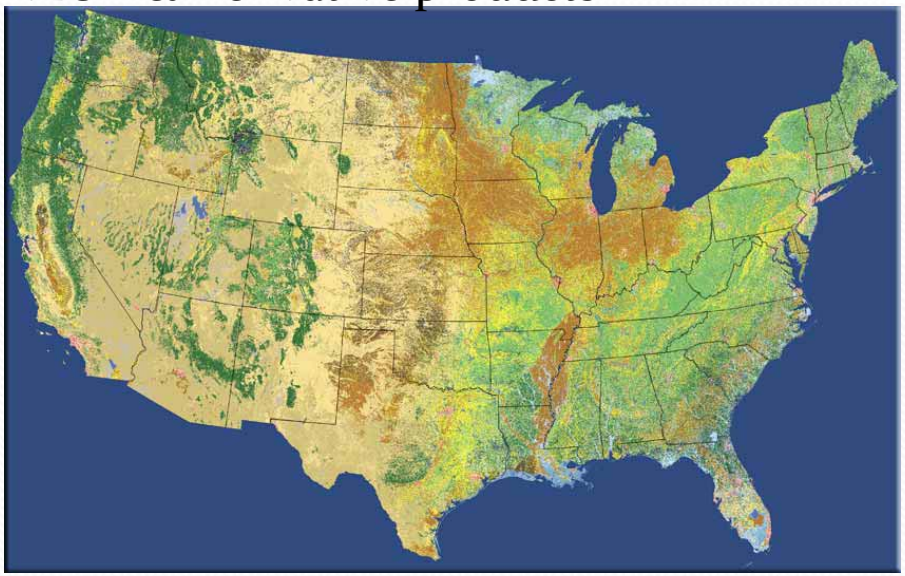
Satellite Imagery - AWiFS & Landsat TM



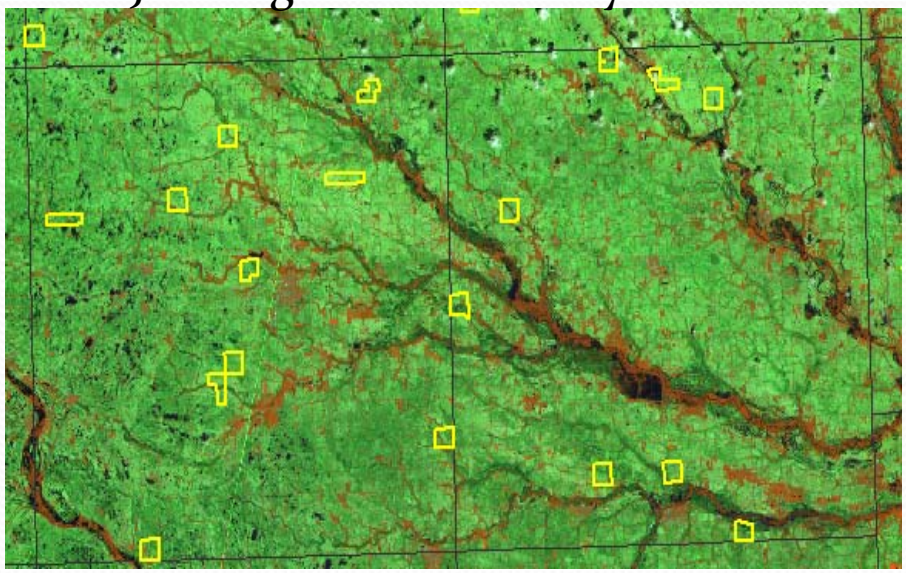
Farm Service Agency – Common Land Unit



NLCD & Derivative products



NASS June Agriculture Survey



Satellite Specifications Compared

	TM	AWiFS
Altitude	705 km	817 km
Equatorial crossing time	9:45 ± 15 minutes	10:30 ± 5 minutes
Temporal Resolution	16 days	5 days
Spatial Resolution	30 x 30 m (reflective) 120 x 120 m (thermal)	56 x 56 m
Radiometric Resolution	8 bit (256)	10 bit (1024)
Spectral Resolution	6 (B, G, R, NIR, SWIR, MIR) + Thermal IR	4 (G, R, NIR,SWIR)
Swath wide	185 km	737 km
Scene size	184 x 152 km	370 x 370 km

Software Suite

Ground Truth Preparation
•ESRI ArcMap

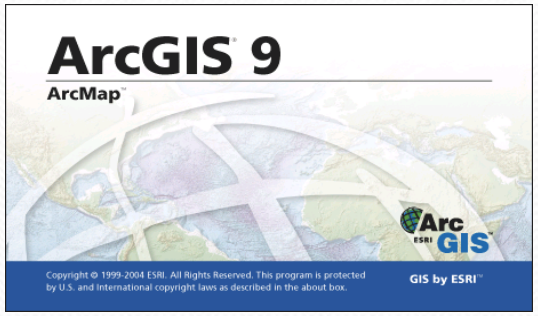
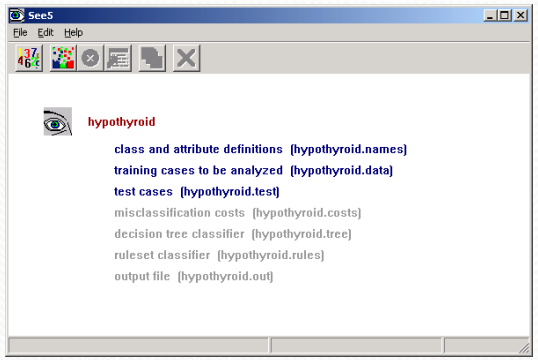


Image Preparation
•Leica Geosystems ERDAS Imagine 9.1

Image Classification
•See 5



Acreage Estimates
•SAS/IML Workshop

Ground Truth – Land Cover

Agriculture Ground Truth

Provided by Farm Service Agency

- Identifies known fields and crops

Divide known fields into 2 sets

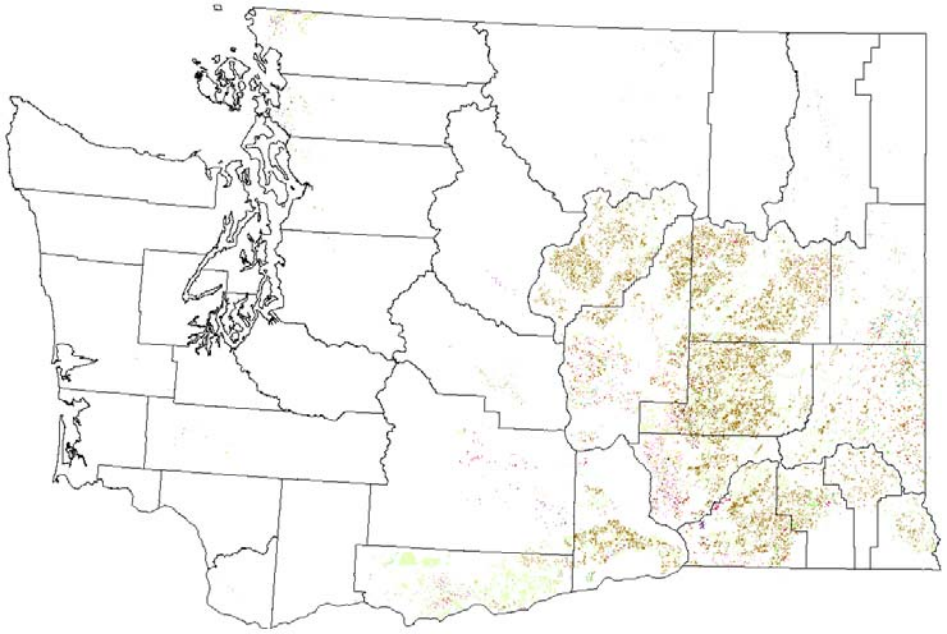
- ½ used for training software
- ½ used for validating results

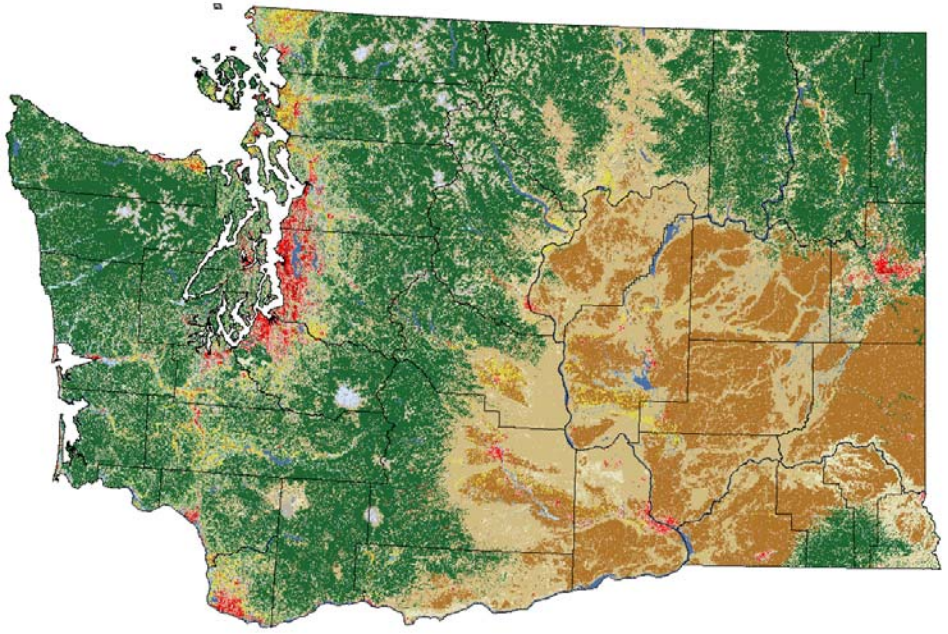
Non-Agriculture Ground Truth

USGS National Land Cover Dataset

Identifies urban infrastructure and non-agriculture land cover

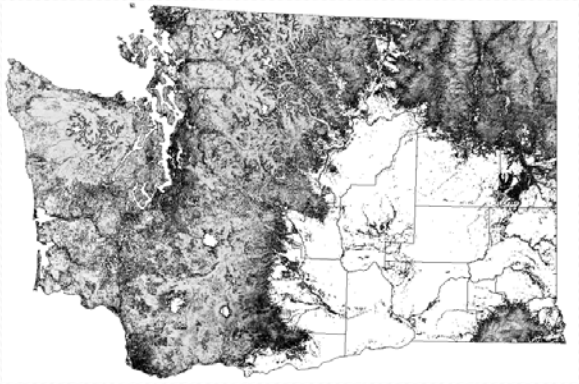
- Forest, grass, water, cities



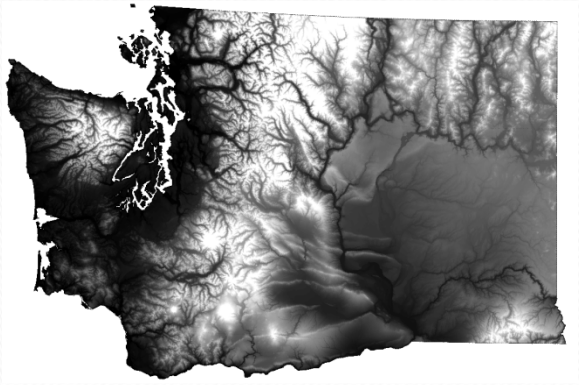


Ground Truth – Ancillary
US Geological Survey

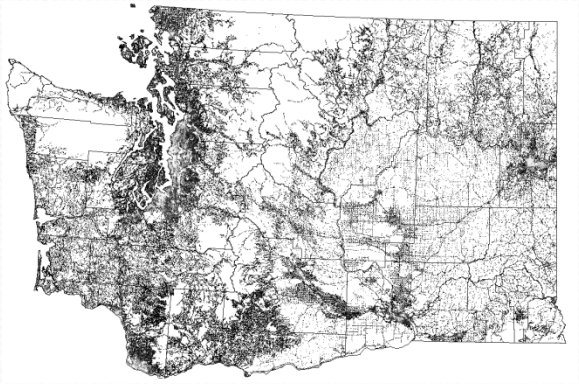
Forest Canopy



Elevation

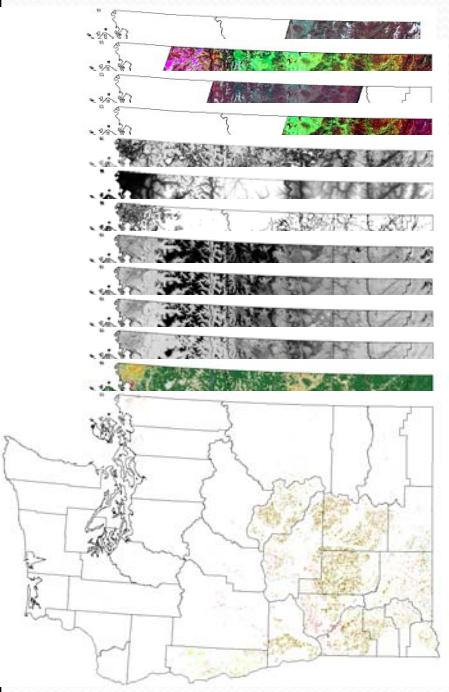


Impervious Surfaces



Ancillary datasets help separate the agricultural landscape; determining agricultural potential

Processing a CDL



Satellite Imagery

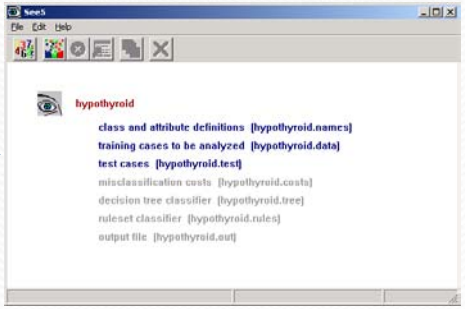
Ancillary Data

MODIS Data

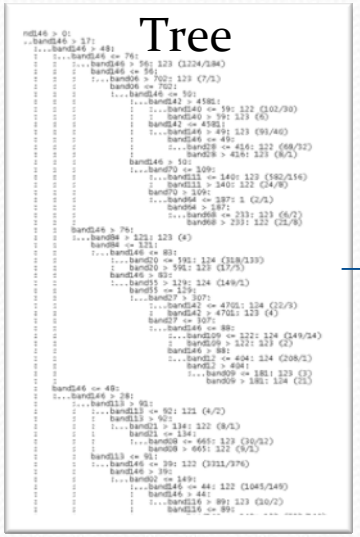
Ground Truth

Sampling

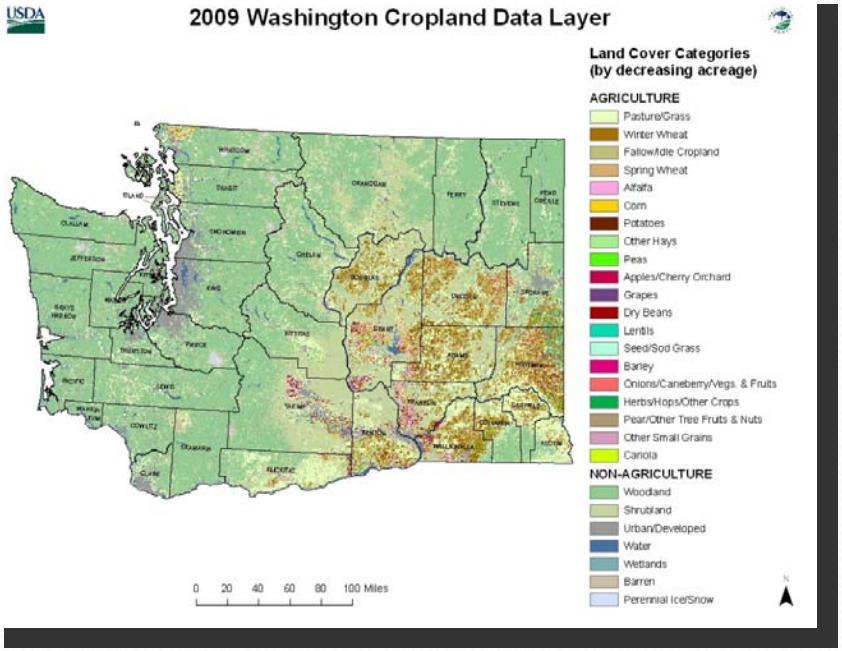
See5



Decision Tree



Classification



Validating CDLs

We measure the accuracy of each CDL

Compare:

Classified pixels from CDL

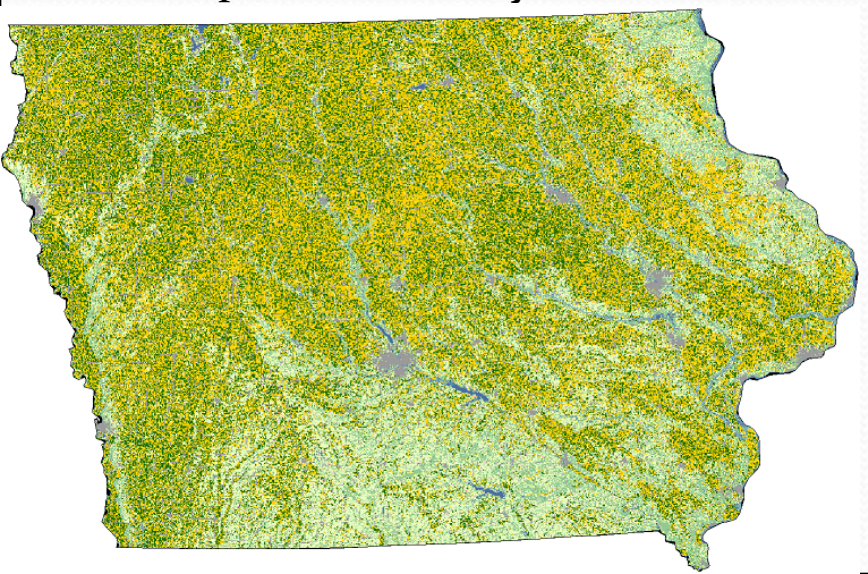
Known pixels, not used for classifying imagery, from FSA

Track:

Producer Accuracy - Errors of Omission - % of pixels from category missing

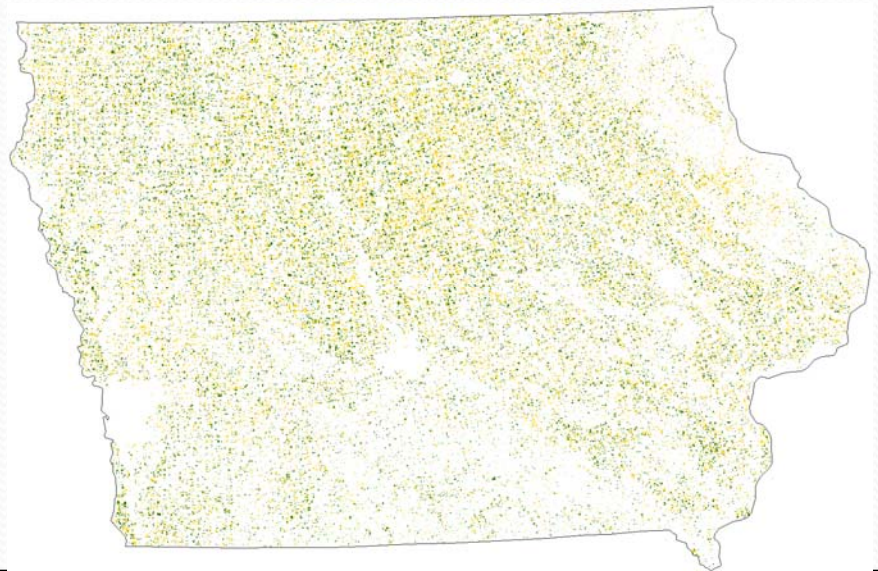
User Accuracy - Errors of Commission - % of pixels from category that are over classified

Cropland Data Layer



versus

Groundtruth – ½ saved for validation



Accuracy Assessments

Crop-specific covers only	*Correct	Accuracy	Error	Kappa
OVERALL ACCURACY	740009	93.56%	6.44%	0.8488

Cover Type	Attribute Code	*Correct Pixels	Producer's Accuracy	Omission Error	Kappa	User's Accuracy	Commission Error	Cond'l Kappa
Corn	1	28358	95.36%	4.64%	0.9528	93.08%	6.92%	0.9297
Cotton	2	11757	95.08%	4.92%	0.9505	94.59%	5.41%	0.9456
Rice	3	2	28.57%	71.43%	0.2857	66.67%	33.33%	0.6667
Sorghum	4	21251	89.85%	10.15%	0.8972	92.46%	7.54%	0.9236
Soybeans	5	12885	86.15%	13.85%	0.8604	88.61%	11.39%	0.8851
Sunflowers	6	102	89.47%	10.53%	0.8947	99.03%	0.97%	0.9903
Peanuts	10	512	90.14%	9.86%	0.9014	92.09%	7.91%	0.9208
Barley	21	785	71.95%	28.05%	0.7194	97.39%	2.61%	0.9739
Durum Wheat	22	48	42.86%	57.14%	0.4286	100.00%	0.00%	1.0000
Spring Wheat	23	205	56.47%	43.53%	0.5647	99.03%	0.97%	0.9903
Winter Wheat	24	580437	97.54%	2.46%	0.9631	94.00%	6.00%	0.9117
Other Small Grains	25	1120	56.97%	43.03%	0.5694	93.57%	6.43%	0.9356
Win Wht /Soyb Dbl Crop	26	14758	79.51%	20.49%	0.7932	90.06%	9.94%	0.8996
Rye	27	13249	66.90%	33.10%	0.6664	91.39%	8.61%	0.9129
Oats	28	2941	64.85%	35.15%	0.6479	95.18%	4.82%	0.9517
Millet	29	439	77.02%	22.98%	0.7701	96.48%	3.52%	0.9648
Canola	31	337	75.90%	24.10%	0.7590	98.83%	1.17%	0.9883
Alfalfa	36	19653	88.21%	11.79%	0.8807	91.78%	8.22%	0.9168
Dry Beans	42	115	88.46%	11.54%	0.8846	93.50%	6.50%	0.9350
Potatoes	43	49	96.08%	3.92%	0.9608	100.00%	0.00%	1.0000
Other Crops	44	50	45.87%	54.13%	0.4587	80.65%	19.35%	0.8064
Misc Vegs & Fruits	47	33	54.10%	45.90%	0.5410	86.84%	13.16%	0.8684
Watermelon	48	24	77.42%	22.58%	0.7742	85.71%	14.29%	0.8571
Peas	53	188	72.59%	27.41%	0.7258	96.91%	3.09%	0.9691
Clover/Wildflowers	58	21	36.21%	63.79%	0.3621	75.00%	25.00%	0.7500
Fallow/Idle Cropland	61	30612	69.78%	30.22%	0.6922	90.48%	9.52%	0.9025
Peaches	67	9	36.00%	64.00%	0.3600	100.00%	0.00%	1.0000
Other Tree Nuts & Fruit	71	69	33.82%	66.18%	0.3382	83.13%	16.87%	0.8313

*Correct Pixels represents the total number of independent validation pixels correctly identifed in the error matrix.

Accuracy Assessments

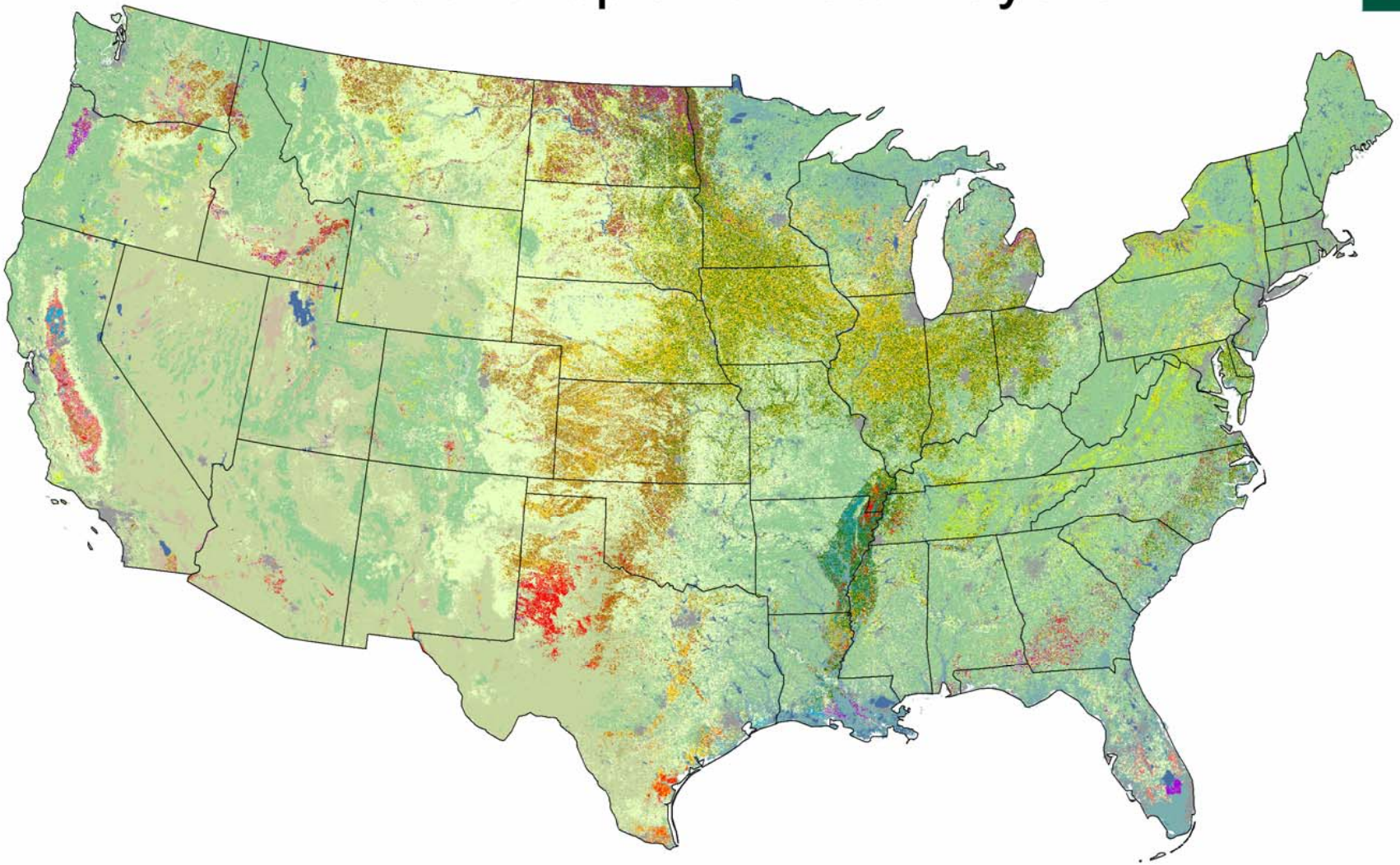
	Cover Type	Attribute Code	*Correct Pixels	Producer's Accuracy	Omission Error	Kappa	User's Accuracy	Commission Error	Cond'l Kappa
IA	Corn	1	2197719	96.58%	3.42%	0.9226	97.86%	2.14%	0.9509
	Soybeans	5	1471094	96.24%	3.76%	0.9392	95.78%	4.22%	0.9320
IL	Corn	1	2258219	98.06%	1.94%	0.9527	98.58%	1.42%	0.9650
	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.

2009 Cropland Data Layers



Land Cover Categories (by decreasing acreage)

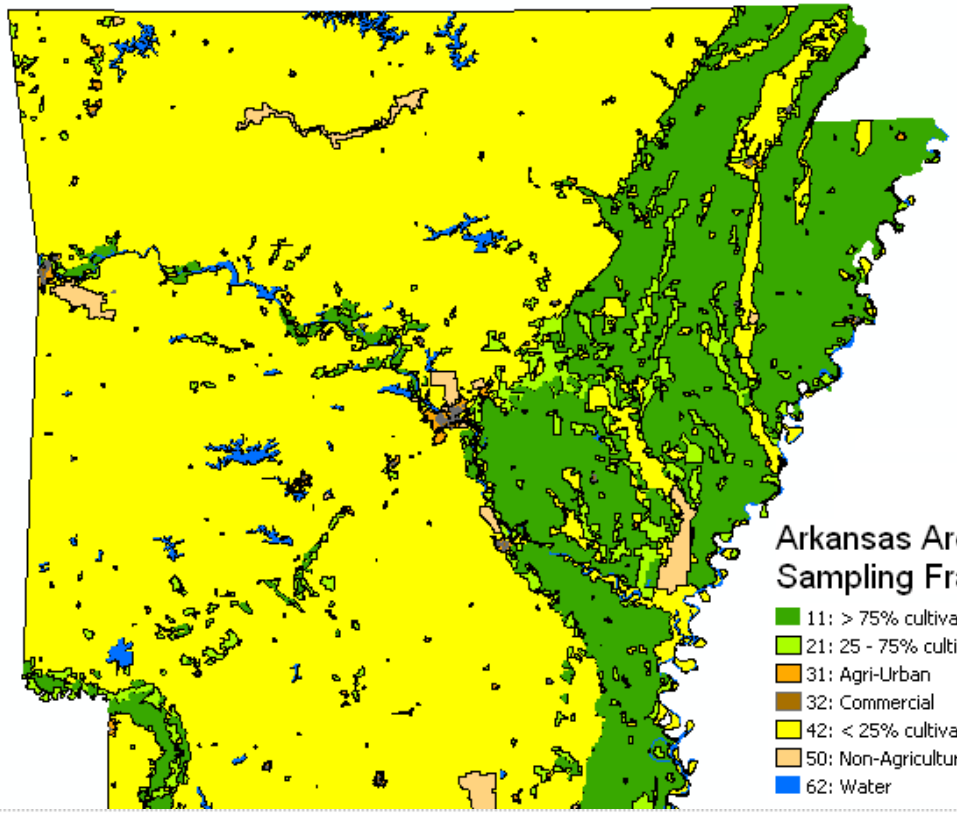
Agriculture

- Pasture/Grass
- Corn
- Soybeans
- All Wheat
- Other Hays
- Fallow/Idle Cropland
- Alfalfa
- Cotton
- Other Crops
- Sorghum
- Vegetables/Fruits/Nuts
- Other Small Grains
- Rice

Non-Agriculture

- Woodland
- Shrubland
- Urban/Developed
- Wetlands
- Water
- Barren
- Perennial Ice/Snow

Remote Sensing
Regression Estimation



PAGE 2

SECTION D - CROPS AND LAND USE ON TRACT

17

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

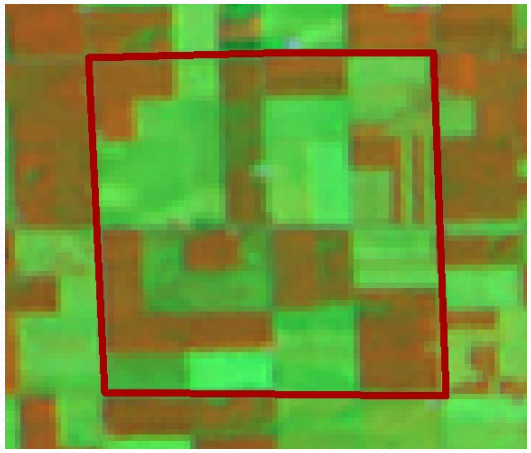
	FIELD NUMBER	01	02	
1.	Total acres in field	828 .	828 .	828
2.	Crop or land use. [*Specify*]			
3.	Occupied farmstead or dwelling	843 .		
4.	Waste, unoccupied dwellings, buildings and structures, roads, ditches, etc.	--- .	--- .	--
5.	Woodland	831 .	831 .	831
6.	Pasture — Permanent (not in crop rotation)	842 .	842 .	842
		856	856	856

Estimation Components:
Area Sampling Frame+
June Area Segment+
Questionnaire

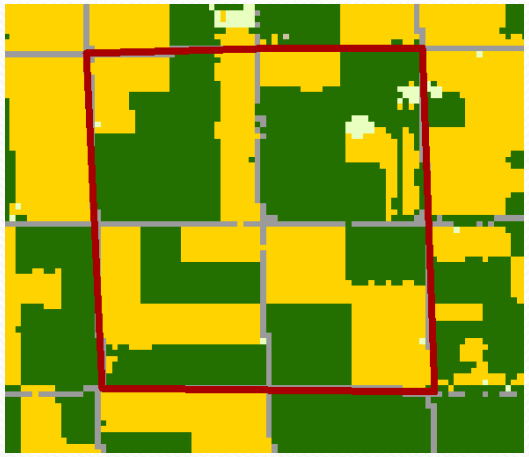
Regression-based Acreage Estimator

Acreage not just about counting pixels

The Goal: Identify areas with defined acreage totals to compare CDL pixel counts
Current Solution: June Agriculture Survey Segments



Vs
.



June Ag Segment

Farmers within segment report 220 acres of corn

Crop Land Data Layer

Pixel Counting estimates 180 acres of corn

Regression-based Acreage Estimator

Acreage not just about counting pixels

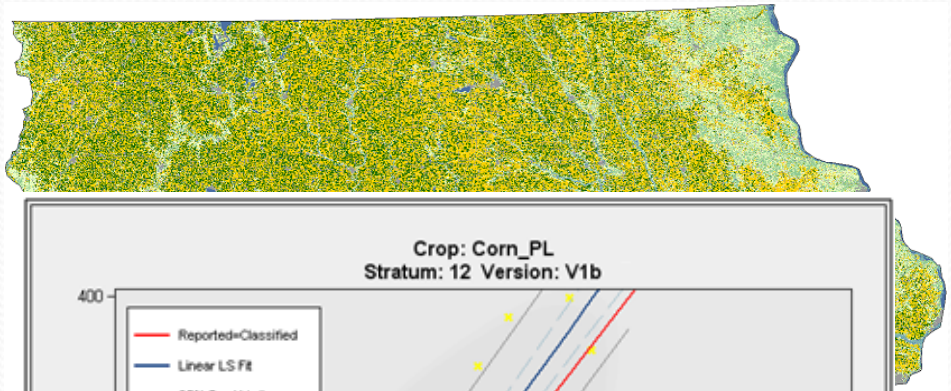
Simple Linear Regression

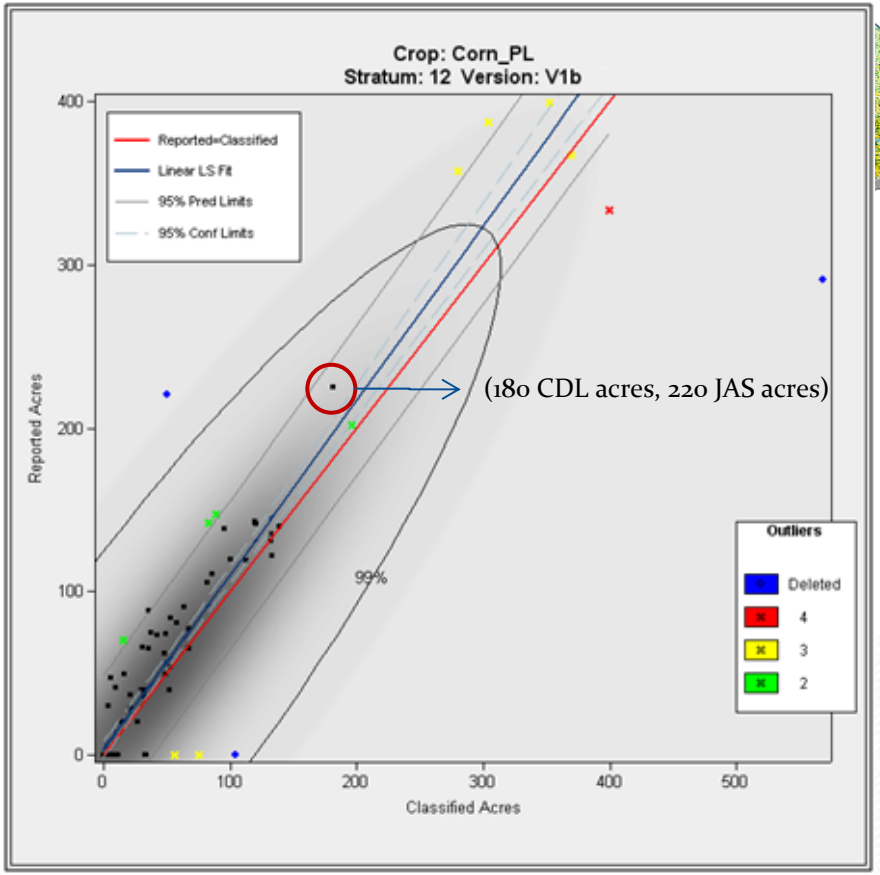
Regression used to relate categorized pixel counts to the ground reference data

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

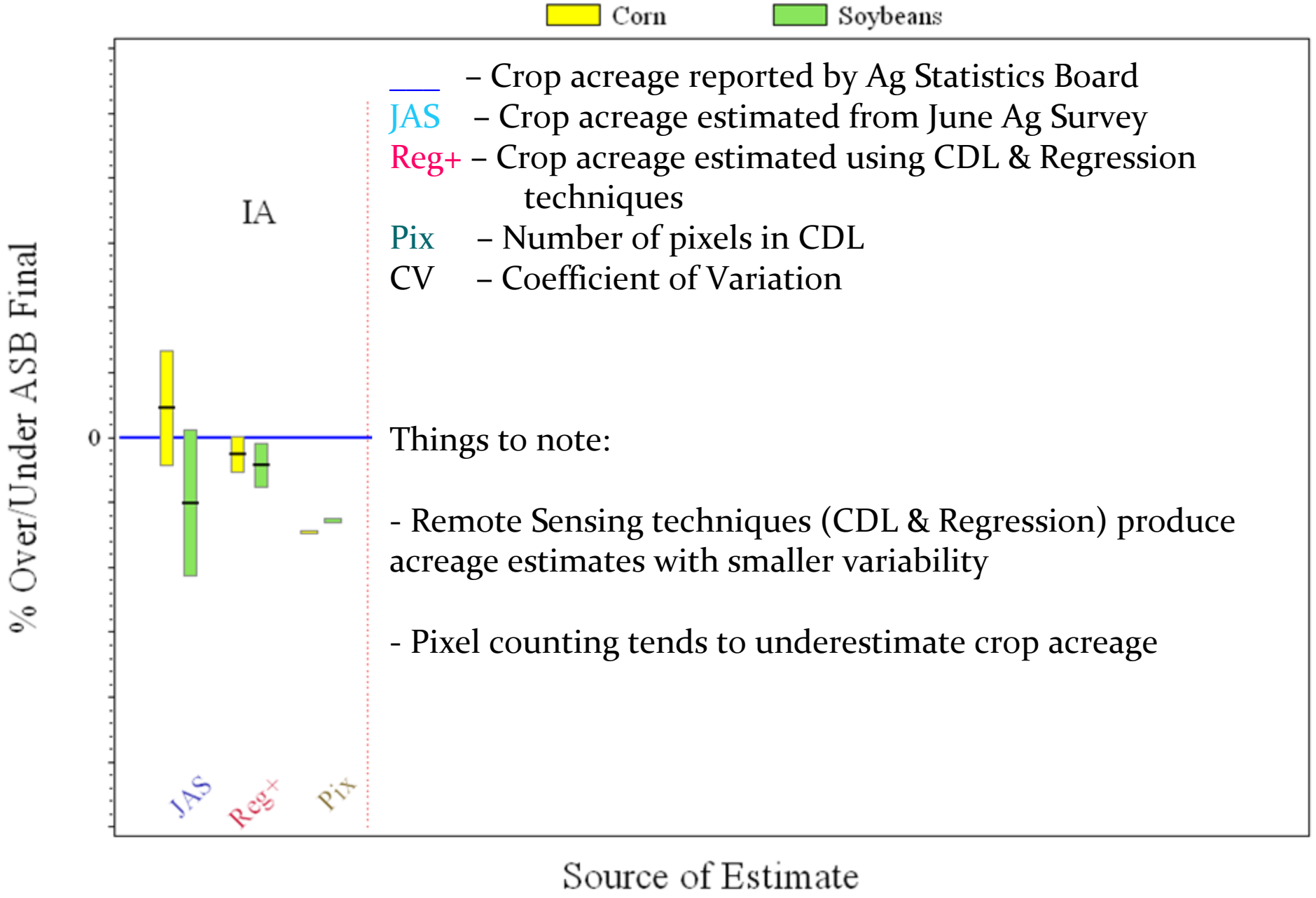
Outlier segment detection - removal from regression analysis

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





2008 State Level Estimates +/- 2 CVs



___ – Crop acreage reported by Ag Statistics Board

JAS – Crop acreage estimated from June Ag Survey

Reg+ – Crop acreage estimated using CDL & Regression techniques

Pix – Number of pixels in CDL

CV – Coefficient of Variation

Things to note:

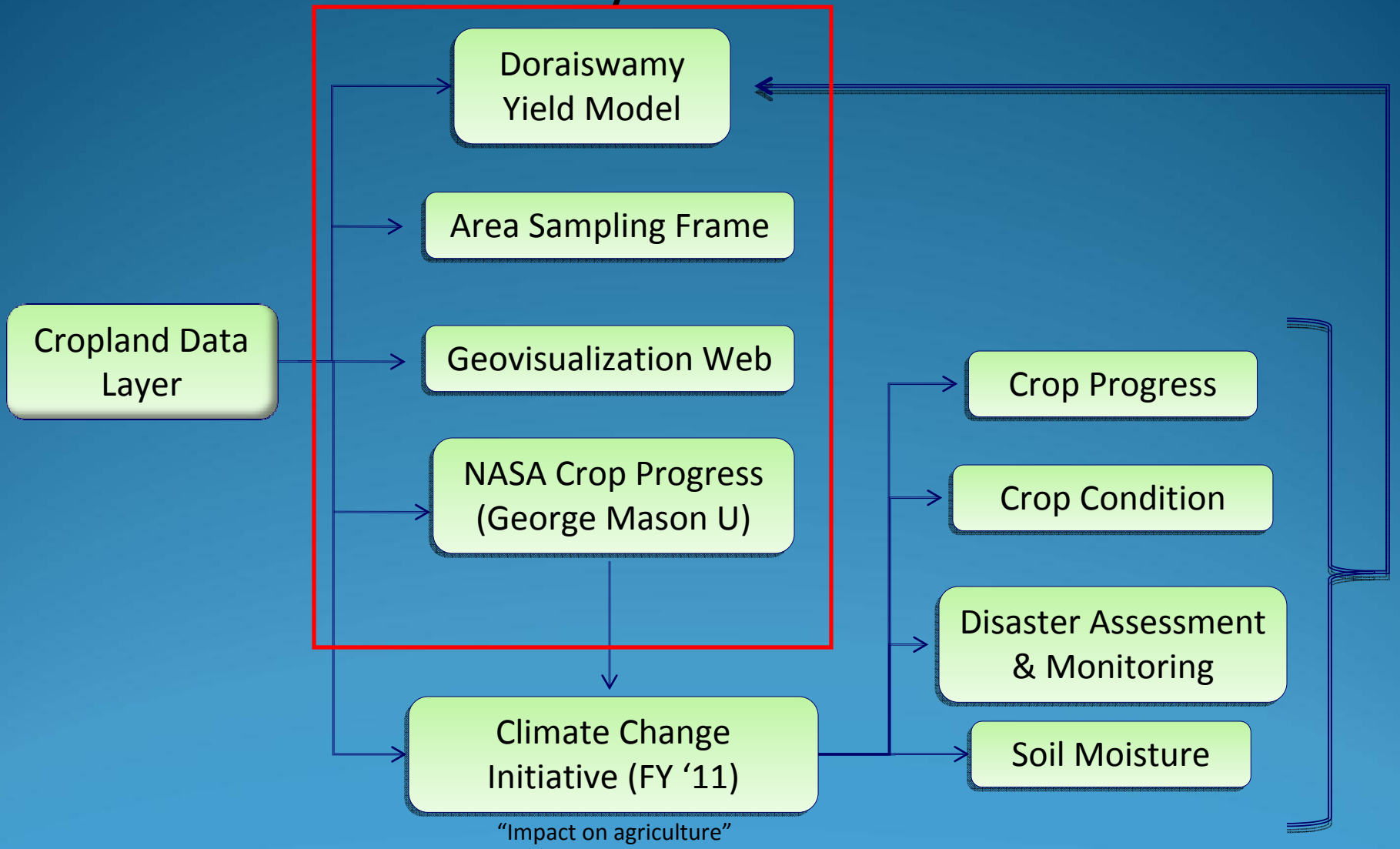
- Remote Sensing techniques (CDL & Regression) produce acreage estimates with smaller variability

- Pixel counting tends to underestimate crop acreage

Number of CDL's & Acreage Indications

Item	Year			
	2007	2008	2009	2010
Total CDL's	21	35	48	48
In Season State Level Estimates	15	19	26	28
Post Season County Level Estimates	15	19	36	36
Crops	9	14	15	16

Geospatial Decision Support Systems

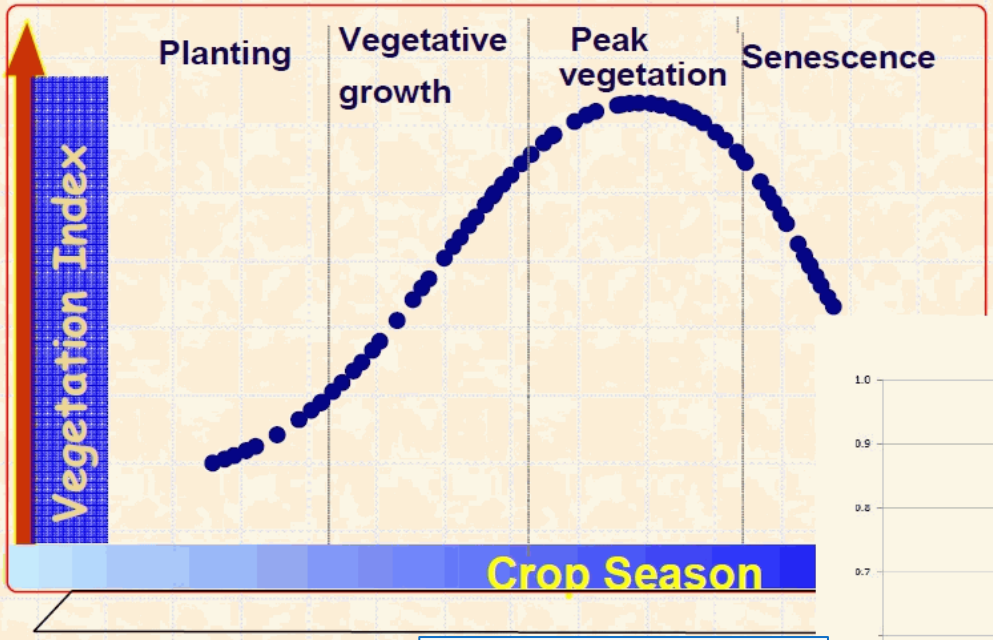


Doraiswamy Remote Sensing Yield Program

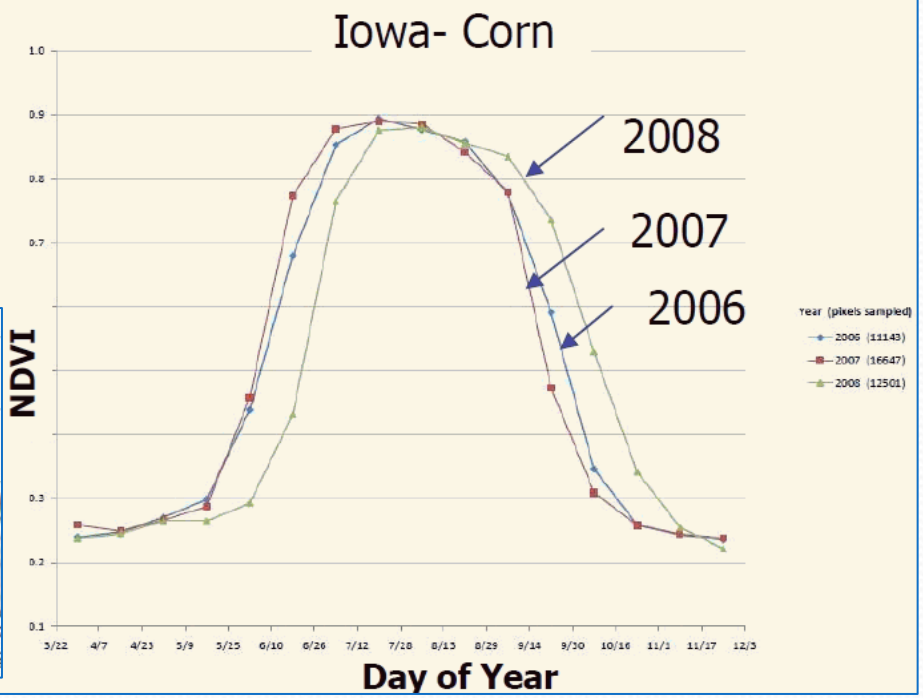
- Operational in 7 major corn & soybean states.
- Tech transfer from USDA/ARS complete
- MODIS sensors used, 8 day +7 day eMODIS; data are smoothed
- Cropland Data Layer platform for masks
- Operational processing – 2 week prototype development reduced to 2 days
- Current issues include:
  - August predictions unlikely with current methodology.
  - Sept. R^2's ~0.850/state for corn
  - Oct. R^2's ~0.93 for corn; 0.810 for soybeans
  - NDVI a reliable predictor for corn yields; soybeans need NDVI/EVI + other variable(s)

Time Series Phenological Profiles

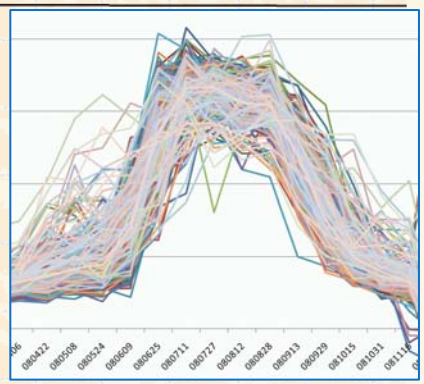
Extracting Yield Parameters from NDVI Profile



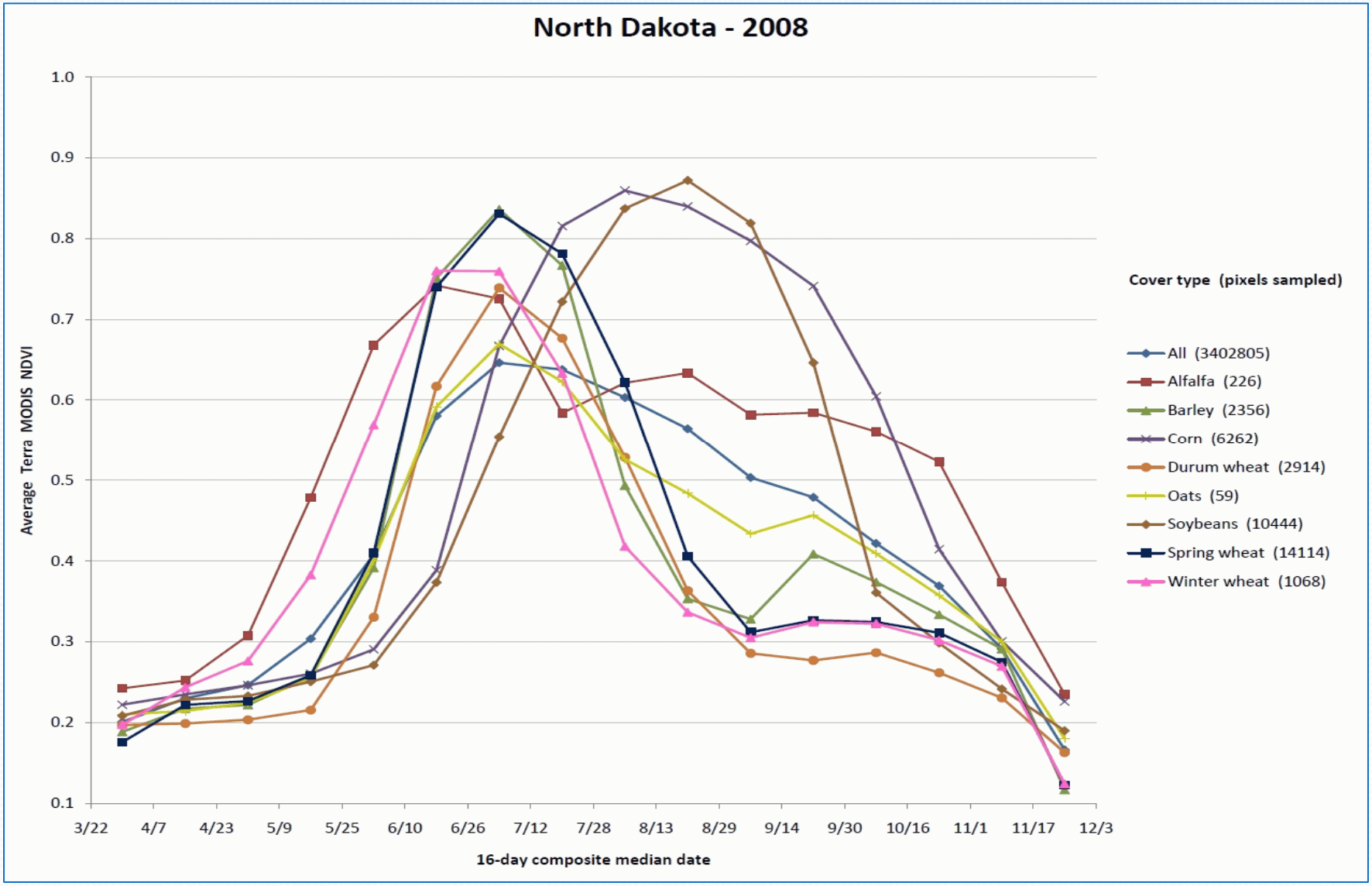
Averaged to state level



At the Pixel level



Phenologies by Crop



Operational Processing

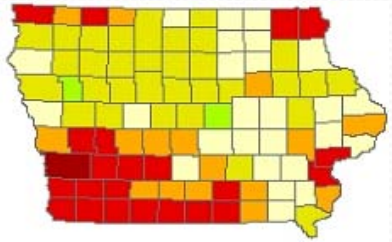
MODIS –VIR/NIR
8-Day Composite
250 m

CDL-based
Corn and Soybean
Classification
Mask

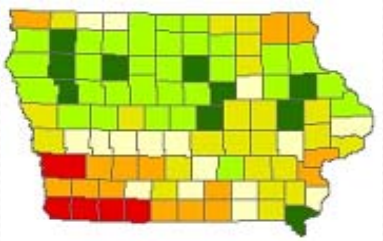
Data Processed, Masked
and State/County
Averaged

Yield Regression Equation
Yield = f (NDVI, Historic Yields, Time)

Current Year Yield

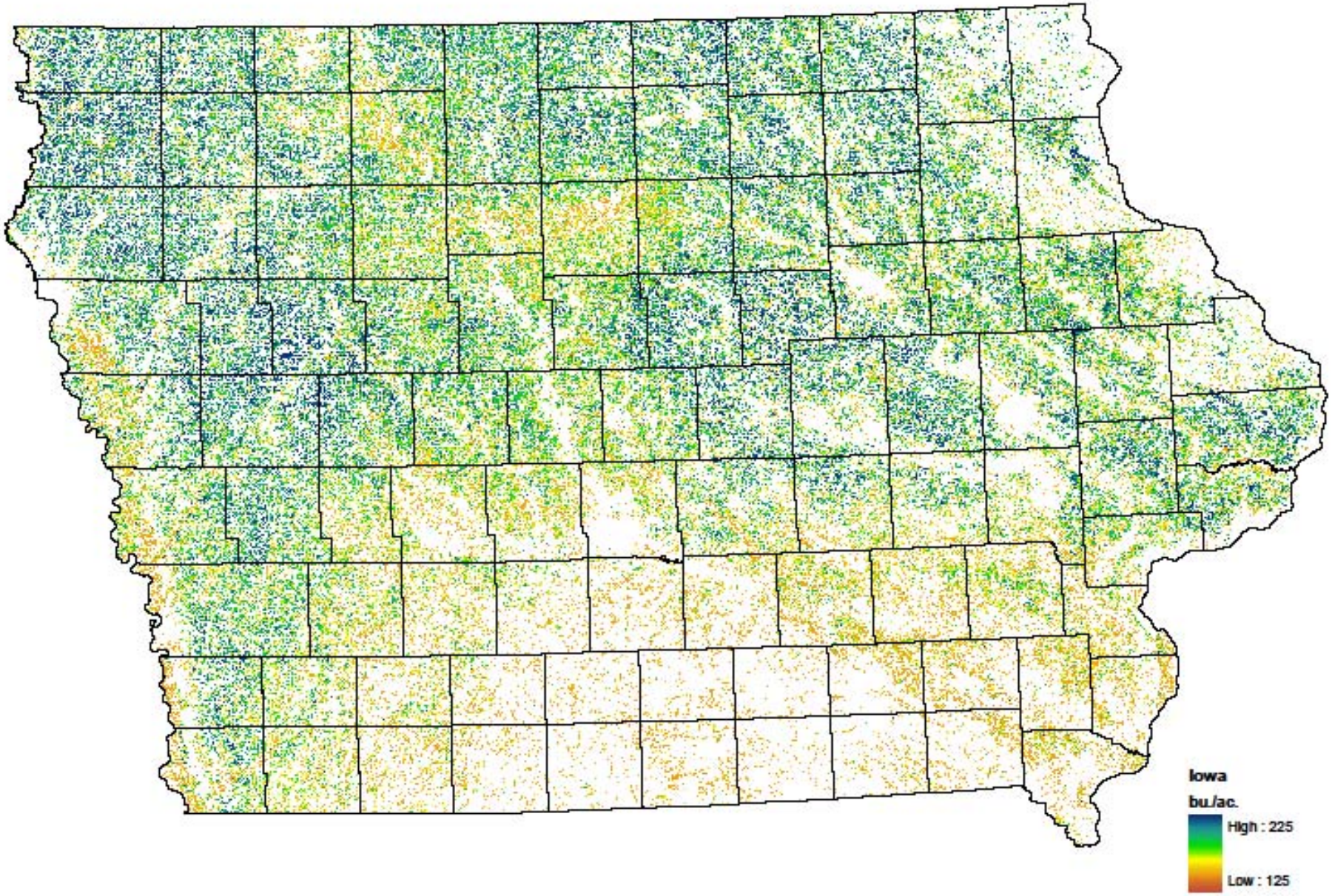


Corn



Soybean

September 1, 2010 Estimated Corn Yield

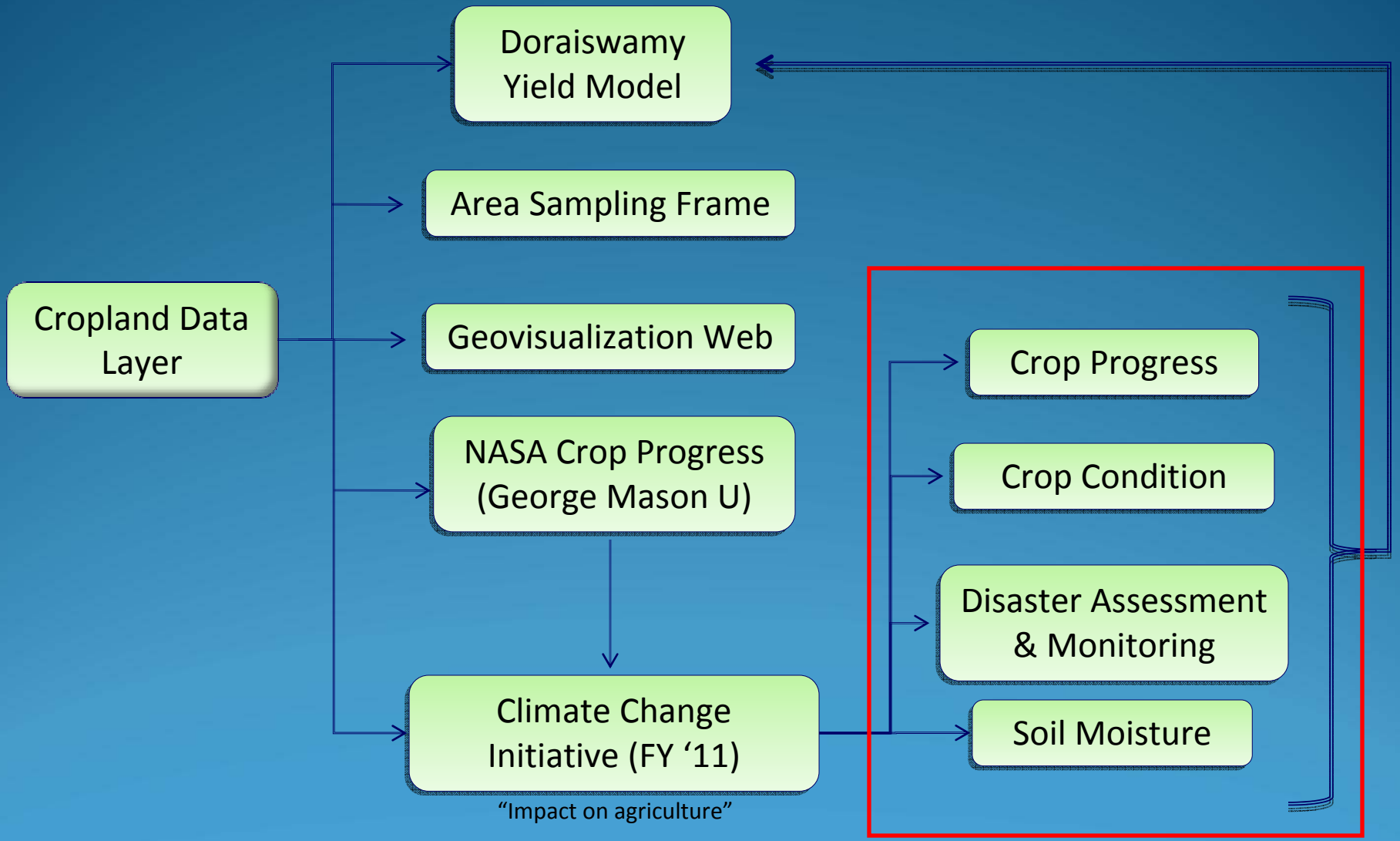


Regression Equation: Current Results

State/Corn	Coefficient of Determination (adj. R^2) – October	Calculated Yield (Bu/Acre)
Iowa	0.9404	*
Illinois	0.9224	*
Indiana	0.9656	*
Minnesota	0.9999	*
Nebraska	0.9563	*
Ohio	0.9832	*
Kansas	0.9830	*

* Confidential (Remote sensing yield indications are generally within 10% of the official NASS Estimate)

Geospatial Decision Support Systems



Design of 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

USDA

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UNITED STATES DEPARTMENT OF AGRICULTURE

Project Goals

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

Why does NASS need a Remote Sensing-Based Crop Progress Monitoring System?

- NASS currently conducts weekly, volunteer-based crop progress surveys, and publishes crop progress and condition reports.
- The current crop progress monitoring is
  - point-based sampling
  - subjectively estimated
  - lacks spatial distribution information
  - Inconsistent results
- Remote sensing technology provides:
  - Objective, consistent, science -based, geospatially covered, time series observations.

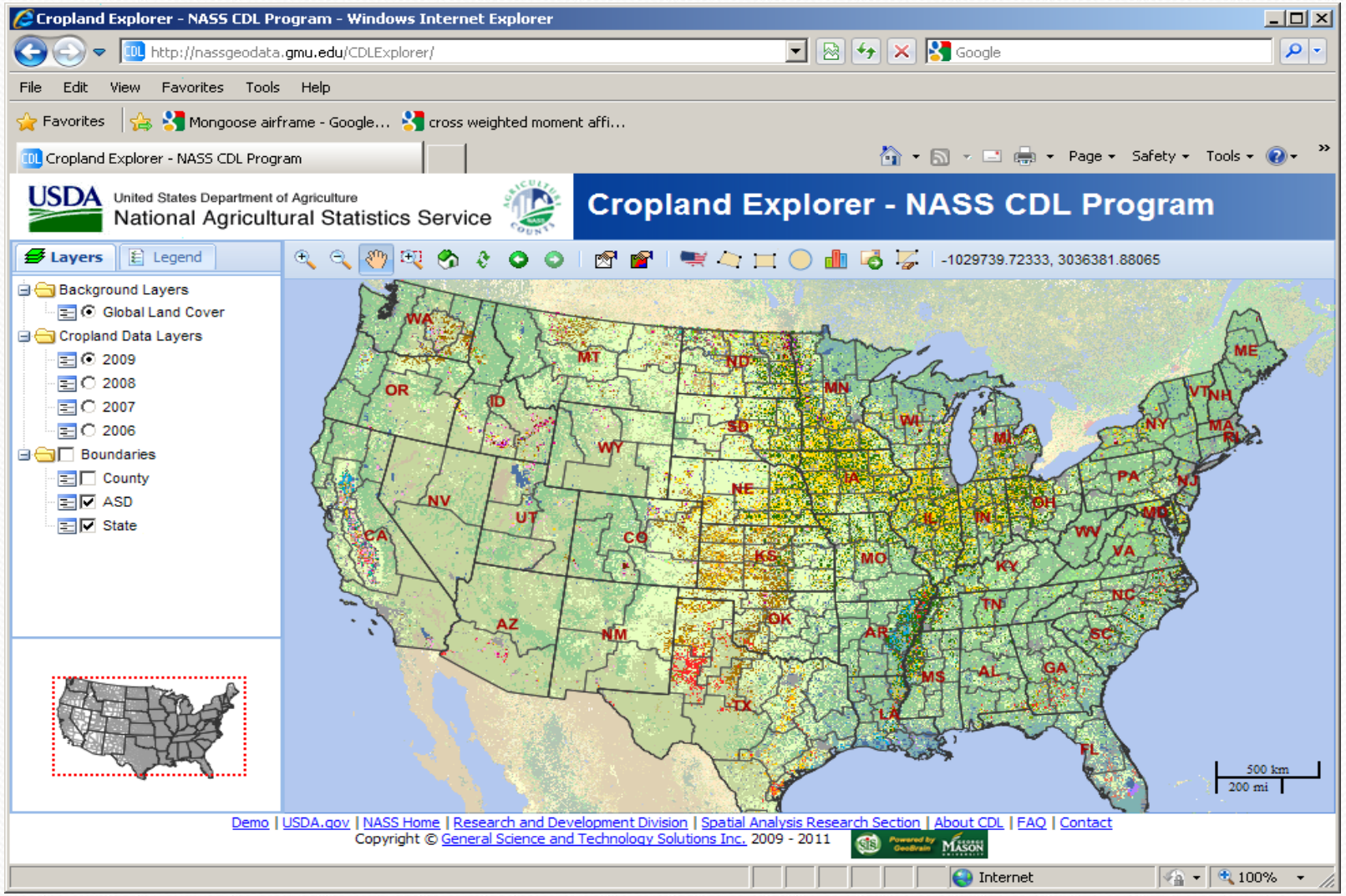
Major System User Requirements

- Minimum reporting area enforced to guarantee privacy.
- Interactive crop progress map generated.
- Pixel-level or field level granularity
- On-the-fly presentation within user defined region.
- Geospatial query capability.
- Crop specific phenological information.
- Equal access and dissemination via spatially enabled Web-based systems.

Design Principles of Operational NCPMS

- The system should be able to assimilate and prepare Earth Observing data for use in agricultural crop growth monitoring and accuracy improving.
- The system should be capable of efficiently (timely) applying Earth Observing research results and data in crop growth development estimation.
- Advanced data mining algorithms and crop models should be implemented and can be plugged-in to readily take advantage of resources available in the system.
- Systematic approaches should be applied to
  - integrate data, services (Web computer software programs)
  - disseminate results through the Web
  - operate the national crop progress monitoring system in a standard-compliant virtual Web environment.

Data Dissemination & Visualization Example – Cropland Explorer



Remote Sensing-based Budget Initiative

Providing Foundational Data Needs for Monitoring and Assessment of the Effects of Climate Change on U.S. Agriculture

Geospatial Information Branch - Spatial Analysis Research Section (SARS),
Fairfax, VA

Areas of Work-NASS & WAOB

- Expansion & Improvements of Existing Efforts
  - Cropland Data Layers and Acreage Estimation
  - Yield Estimation for state and county levels
- New Research & Development Areas

  Crop Progress, Crop Condition, Soil Moisture,

  Disaster Monitoring and Assessments
- Create Digital GeoArchive
- Delivery of Products via Internet

New Research Areas

- ***Crop Progress*** **– Provide quantitative assessments by stage of crop 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**

Official USDA Publications Impacted by the Initiative

NASS
FACT FINDERS FOR AGRICULTURE
UNITED STATES DEPARTMENT OF AGRICULTURE

Crop Progress

Washington, D.C.

Released June 29, 2009, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture. For information on *Crop Progress* call Julie Schmidt at (202) 720-7621, office hours 7:30 a.m. to 4:00 p.m. ET.

USDA

Iowa Crops & Weather

USDA – National Agricultural Statistical Service – Iowa Field Office
In Cooperation with the Iowa Department of Agriculture and Land Stewardship
210 Walnut, Room 833 • Des Moines, Iowa 50309-2195
515-284-4340 • 1-800-772-0825 • FAX 515-284-4342 • nass-ia@nass.usda.gov
To access NASS reports – http://www.nass.usda.gov

Issued June 29, 2009

Vol 09-17 — For the week ending June 28, 2009

NASS
FACT FINDERS FOR AGRICULTURE
UNITED STATES DEPARTMENT OF AGRICULTURE

Weekly Weather and Crop Bulletin

Washington, D.C.

Released September 1, 2009, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture. For information on *Weekly Weather and Crop Bulletin* call Julie Schmidt at (202) 720-7621, office hours 7:30 a.m. to 4:00 p.m. ET.

Volume 97, No. 9 — http://www.usda.gov/oce/weather — March 2, 2010

WEEKLY WEATHER AND CROP BULLETIN

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

U.S. DEPARTMENT OF AGRICULTURE
National Agricultural Statistics Service
and World Agricultural Outlook Board

NASS
FACT FINDERS FOR AGRICULTURE
UNITED STATES DEPARTMENT OF AGRICULTURE

Crop Production

Washington, D.C.

Released February 9, 2010, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture. For information on *Crop Production* call (202) 720-2127, office hours 7:30 a.m. to 4:00 p.m. ET.

World Agricultural Outlook Board
waob
ISSN: 1554-9089

World Agricultural Supply and Demand Estimates

United States Department of Agriculture

Office of the Chief Economist | Agricultural Marketing Service, Farm Service Agency | Economic Research Service, Foreign Agricultural Service

WASDE - 479 — Approved by the World Agricultural Outlook Board — February 9, 2010

Depiction of Soil Moisture

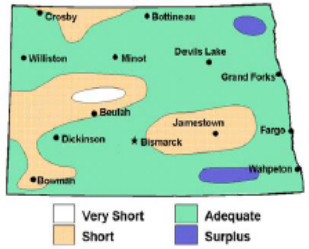
Current > Subjective-based

NORTH DAKOTA CROP WEATHER REPORT, Week Ending August 16, 2009 — Page Two

Soil Moisture Supplies
North Dakota, Week Ending August 16, 2009

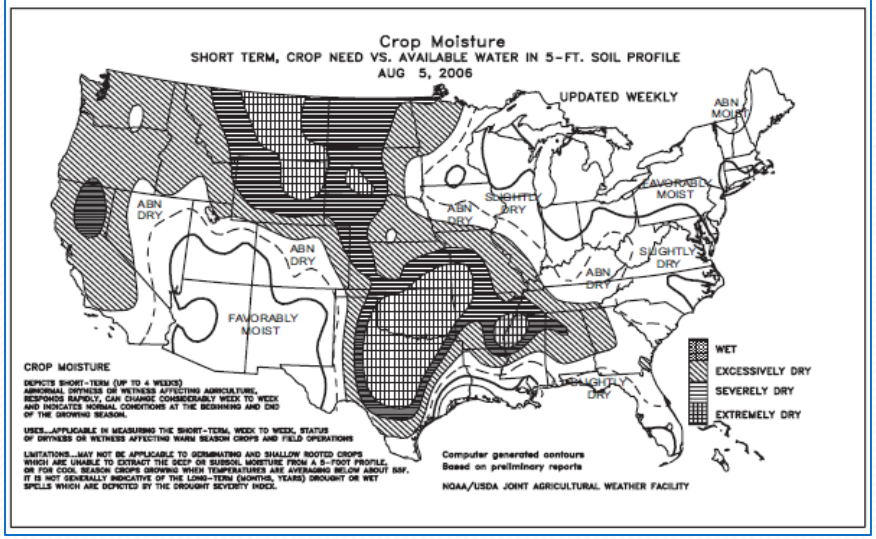
Date	Week Ending August 16, 2009	Week Ending August 9, 2009	Week Ending August 16, 2008	2004-2008 Avg
	Percent	*Percent*	*Percent*	*Percent*
Topsoil				
Very Short	1	1	19	17
Short	22	27	24	27
Adequate	75	70	56	53
Surplus	2	2	1	3
Subsoil				
Very Short	1	1	24	18
Short	21	20	29	28
Adequate	75	75	47	51
Surplus	3	4	0	3

Topsoil Moisture Supplies
North Dakota, August 16, 2009



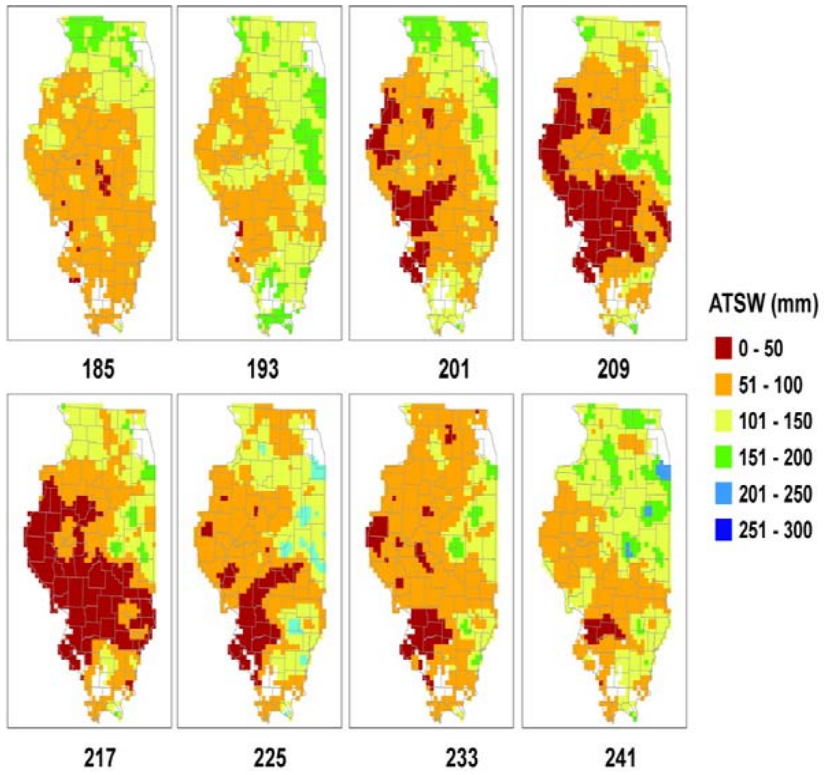
2 — Weekly Weather and Crop Bulletin — August 8, 2006

Crop Moisture
SHORT TERM, CROP NEED VS. AVAILABLE WATER IN 5-FT. SOIL PROFILE
AUG 5, 2006

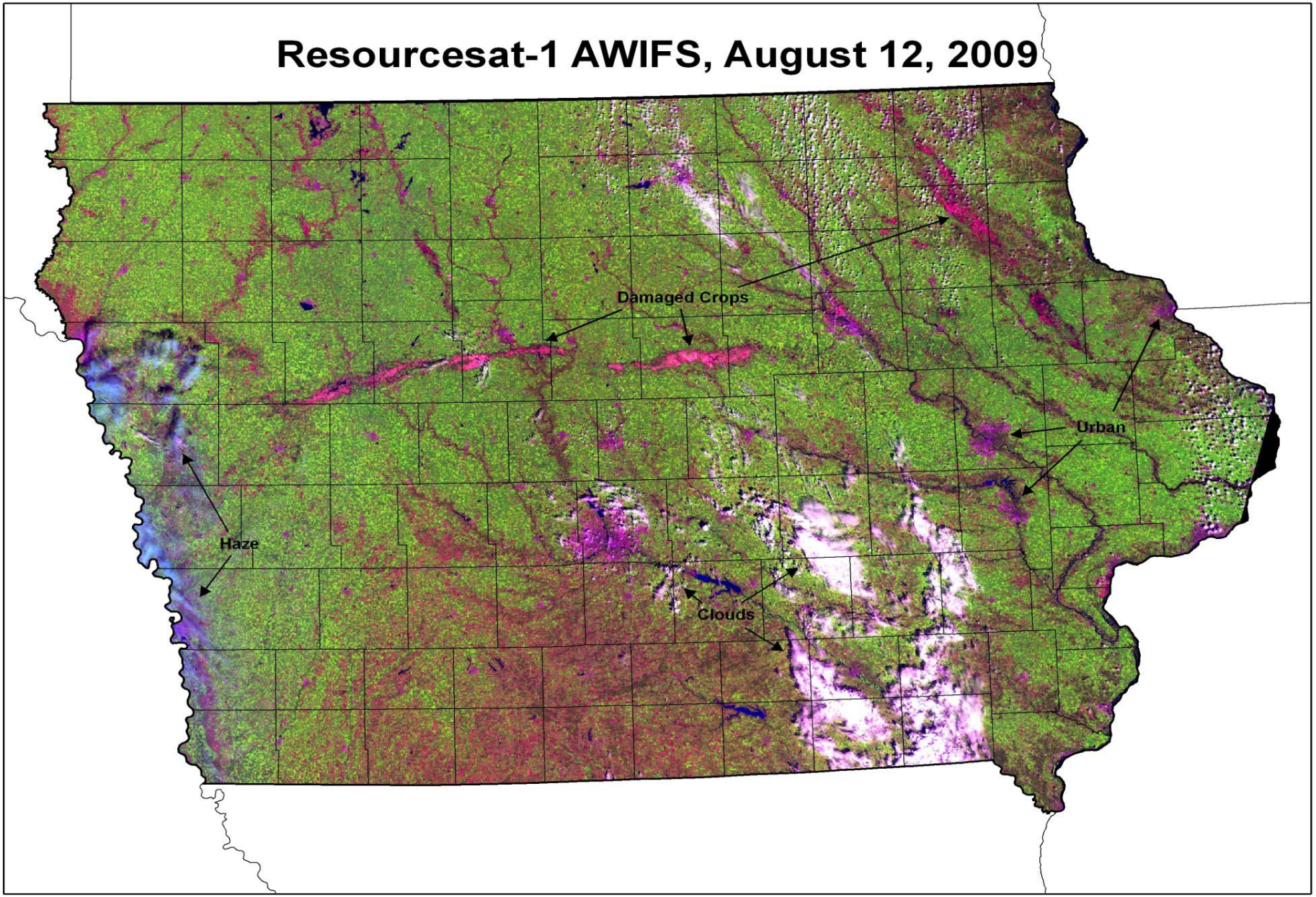


Future > Science-based

Corn 8-Day Available Transpirable Soil Water (ATSW), IL-2006

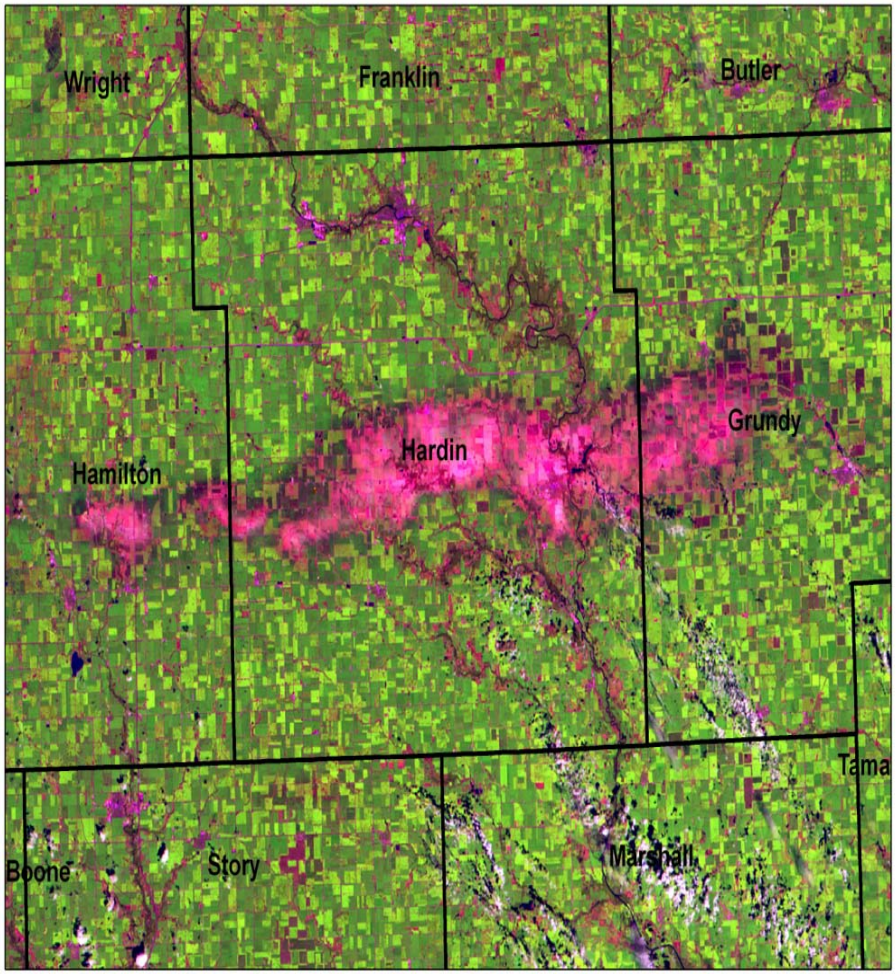


Natural Disaster Assessments – Visual Reference

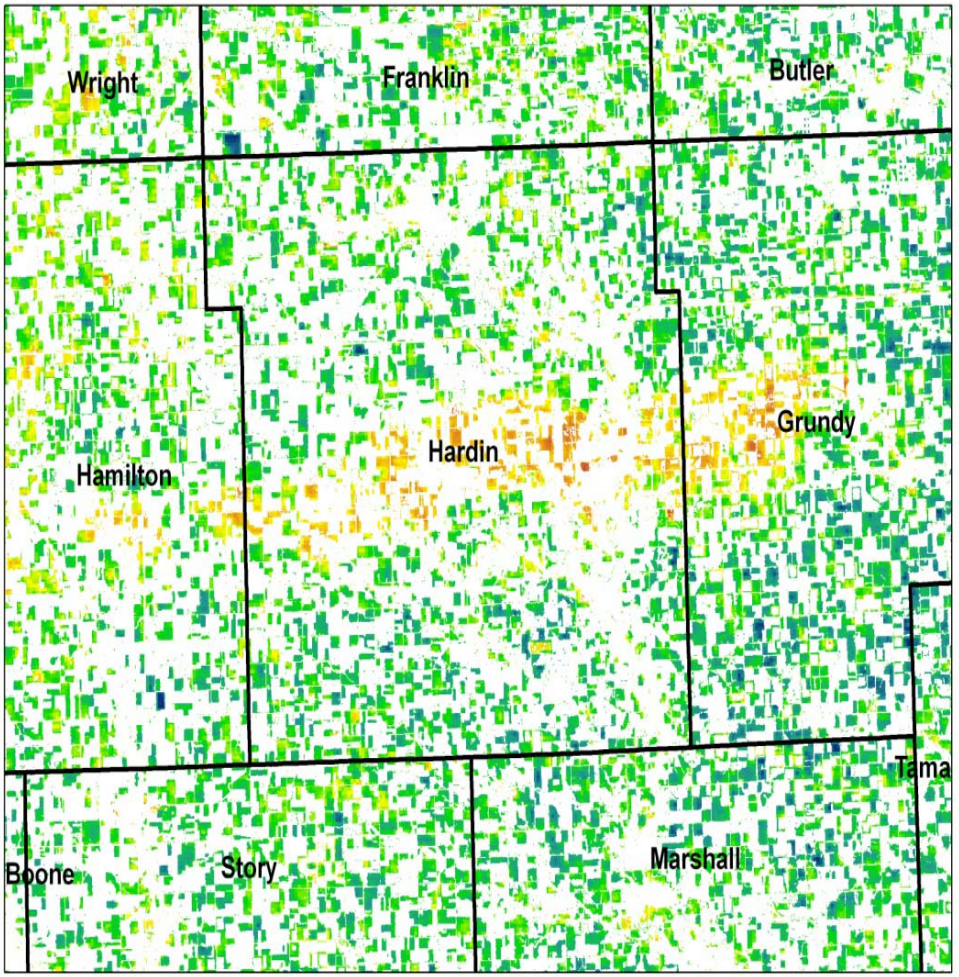


Natural Disaster Assessments - Prototype Crop Yield Map

Raw AWiFS



Yield Impact



Major Issues Facing Our Program

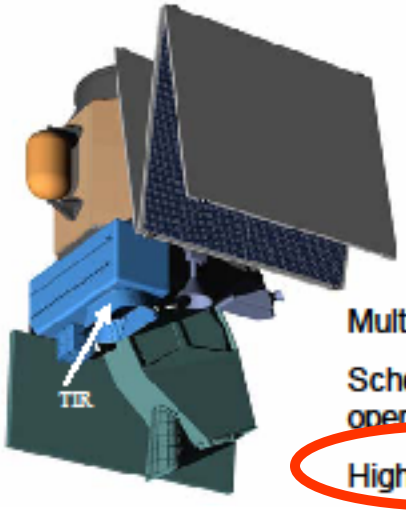
NEAR TERM

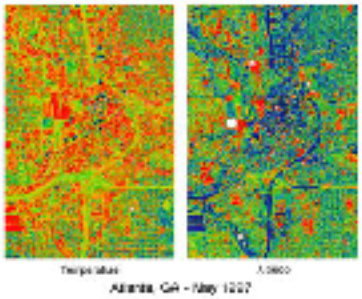
- Sensors, sensors, sensors!
  - Without Landsat TM, 2010 would have been a huge setback for remote sensing in NASS!
  - AWiFS solar panel partial failure
  - Future Use & Access to SPOT VEG unsure
  - Resourcesat 2 launch, and priority for U.S. acquisitions?
- Flow of imagery must be uninterrupted during growing season

LONG TERM

- MRLI support to U.S. civilian agencies unclear.
- MODIS replacement (VIRS) a downgrade
- Operational needs have evolved beyond current strategies to support them.
- NASS will encourage USDA move to push for higher priority launch of HyspIRI sensor.

HyspIRI Thermal Infrared Multispectral (TIR) Science Measurements





Multispectral Scanner

Schedule: 4 year phase A-D, 3 years operations

High Heritage

Science Questions:

TQ1. Volcanoes/Earthquakes (MA,FF)

– *How can we help predict and mitigate earthquake and volcanic hazards through detection of transient thermal phenomena?*

- *TQ2. Wildfires (LG,DR)*

– *What is the impact of global biomass burning on the terrestrial biosphere and atmosphere, and how is this impact changing over time?*

- *TQ3. Water Use and Availability, (MA,RA)*

– *How is consumptive use of global freshwater supplies responding to changes in climate and demand, and what are the implications for sustainable management of water resources?*

- *TQ4. Urbanization/Human Health, (DQ,GG)*

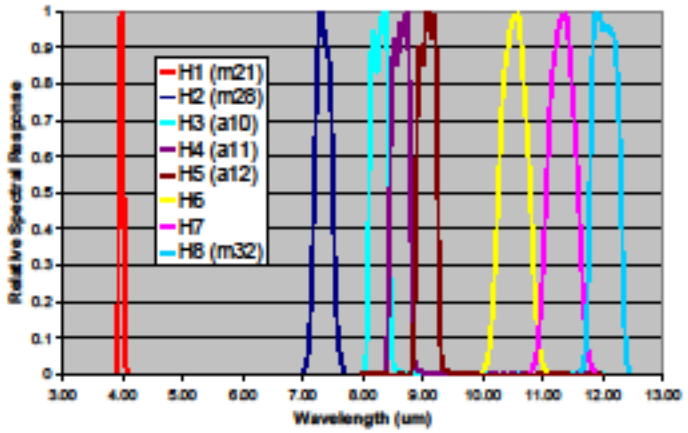
– *How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?*

- *TQ5. Earth surface composition and change, (AP,JC)*

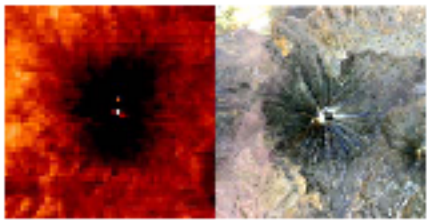
– *What is the composition and temperature of the exposed surface of the Earth? How do these factors change over time and affect land use and habitability?*

Measurement:

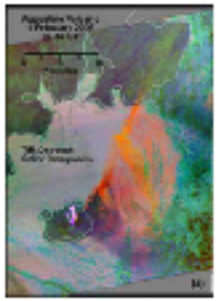
- 7 bands between 7.5-12 µm and 1 band at 4 µm
- 60 m resolution, 5 days revisit
- Global land and shallow water



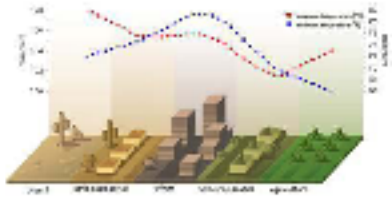
Andean volcano heats up



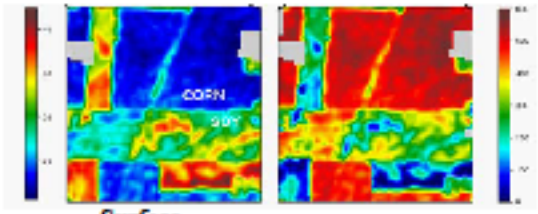
Volcanoes



Urbanization



Water Use and Availability



Surface Temperature

Evapotranspiration

HyspIRI compared with possible International Imaging Spectroscopy Missions

Only HyspIRI provides the full spectrum of data required to address climate-carbon cycle feedbacks articulated in the NRC Decadal Survey

HyspIRI Provides Seasonal and Annual Global Coverage that Uniquely Addresses Critical Gaps in Climate Research and Ecosystem Understanding.

>100 years for international mission to equal 1 year of HyspIRI

Country	Instrument	Swath km	Pixel Size, m	Terrestrial Coverage in 19 days	Repeat interval, days	TIR capability
USA	**HyspIRI**	**150**	**60**	**100%**	**19**	**8 TIR bands**
Germany	EnMAP	30	30	<1%	--	NO
Italy	PRISMA	30-60	20-30	<1%	--	NO
Japan?	ALOS3	30	30	<1%	--	NO
India?	IMS Resource Sat-3	25	25	<1%	--	1 TIR band

US, HyspIRI: a full spectral range (380 to 2500 at 10 nm), high SNR, uniform, 60m spatial with 150 km swath imaging spectrometer and multiband thermal imager (8 band thermal imager from 3-12 μm).

Other countries are occasionally mentioned (China, South Africa, South Korea, etc.). All are proposing first generation small sample process/application missions with scattered terrestrial coverage and no TIR imager

Key Features of NASA HyspIRI

- 1) Hyperspectral: Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer - Full spectrum 380 to 2500 nm, 60 m resolution, with 150 km swath, repeat coverage 19 days

- 2) Multispectral Thermal InfraRed (TIR) Scanner - 7 bands between 7.5-12 µm and 1 band at 4 µm, 60 m resolution, with 600 km swath, repeat coverage 5 days

- Potential for climate/water/carbon/land use monitoring/wildfires/droughts

IN MEMORIUM

Dr. Paul C. Doraiswamy
April 7, 1948 - May 8, 2010
Friend and Colleague