USDA Remote Sensing Overview 2013

Glenn R. Bethel
USDA Remote Sensing Advisor
April 16, 2013

MODIS Terra. March 25, 2013

Outline

- USDA Aerial Programs
- USDA Use of Satellite Imagery
- Disasters / Hurricane Sandy

USDA

= USDA Remote Sensing Agencies
13 of 19 Agencies

- SECRETARY
  - Deputy Secretary
    - Director of Communications
    - Inspector General
    - General Counsel
    - Assistant Secretary for Congressional Relations
    - Assistant Secretary for Administration
      - Chief Information Officer
      - Chief Financial Officer
      - Executive Operations
      - Homeland Security
    - Assistant Secretary for Civil Rights
    - Under Secretary for Natural Resources and Environment
      - Forest Service
      - Natural Resources Conservation Service
    - Under Secretary for Farm and Foreign Agricultural Services
      - Farm Service Agency
      - Foreign Agricultural Service
      - Risk Management Agency
    - Under Secretary for Rural Development
      - Rural Utilities Service
      - Rural Housing Service
      - Rural Business Cooperative Service
    - Under Secretary for Food, Nutrition, and Consumer Services
      - Food and Nutrition Service
      - Center for Nutrition Policy and Promotion
    - Under Secretary for Food Safety
      - Food Safety and Inspection Service
    - Under Secretary for Research, Education, and Economics
      - Agricultural Research Service
      - National Institute of Food and Agriculture
      - Economic Research Service
      - National Agricultural Library
      - National Agricultural Statistics Service
    - Under Secretary for Marketing and Regulatory Programs
      - Agricultural Marketing Service
      - Animal and Plant Health Inspection Service
      - Grain Inspection Packers and Stockyards Administration

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

FSA FARM SERVICE AGENCY

Rural Development

ARS

NIFA

APHIS

NRCS Natural Resources Conservation Service

USDA FOREIGN AGRICULTURAL SERVICE

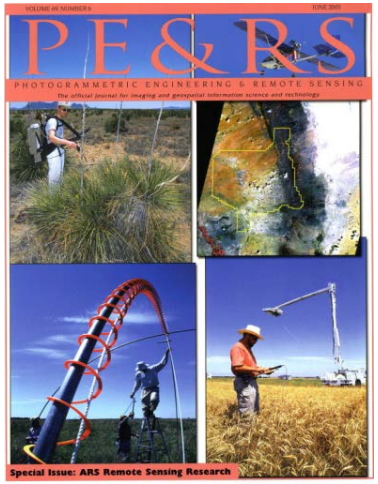
RMA

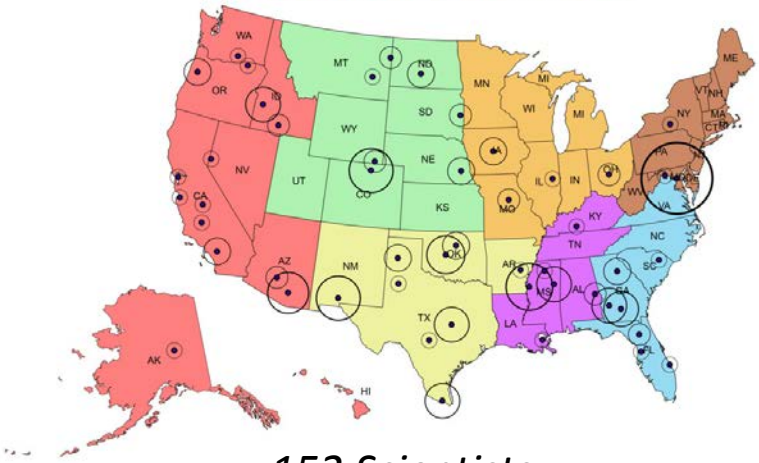
NASS

ERS ECONOMIC RESEARCH SERVICE United States Department of Agriculture

USDA Agriculture Research Service (ARS) Remote Sensing Research

- Yield, Residue, Carbon
- Soil Moisture
- Evapotranspiration & Drought
- Natural Resource Management
- Nutrient, Forage Status
- Invasive Species & Weeds
- Pesticide Management
- System Calibration & Validation
- Rapid Phenotyping

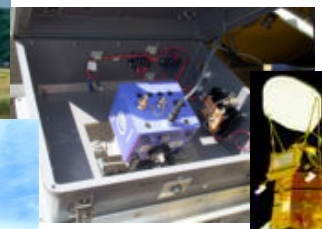


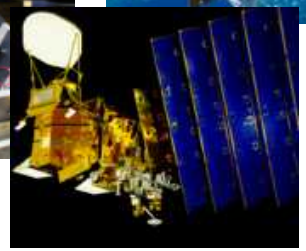


152 Scientists

Systems, Scales & Science

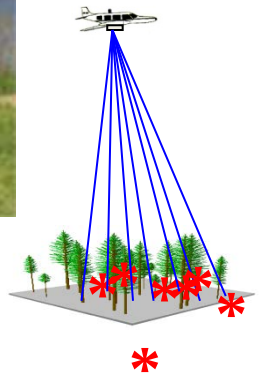
Stationary systems
On-the-go systems
Airborne systems
Satellite systems





Science Teams

Parameter retrieval
Model parameterization
Index development



Visible
Near IR
Short wave IR
Middle IR
Thermal IR
Microwave
Laser

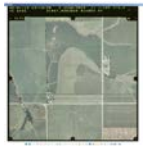
Hardware specifications
Algorithm development
Applications development

USDA Aerial Imagery Programs and Funding Sources

- **National Agriculture Imagery Program (NAIP)**

- **Forest Service Resource Photography**

- **National Resources Inventory (NRI)**



- **Stewardship Lands Photography**

FSA Film Archive at APFO

Historical Aerial Photo Projects from 1955 to 1995

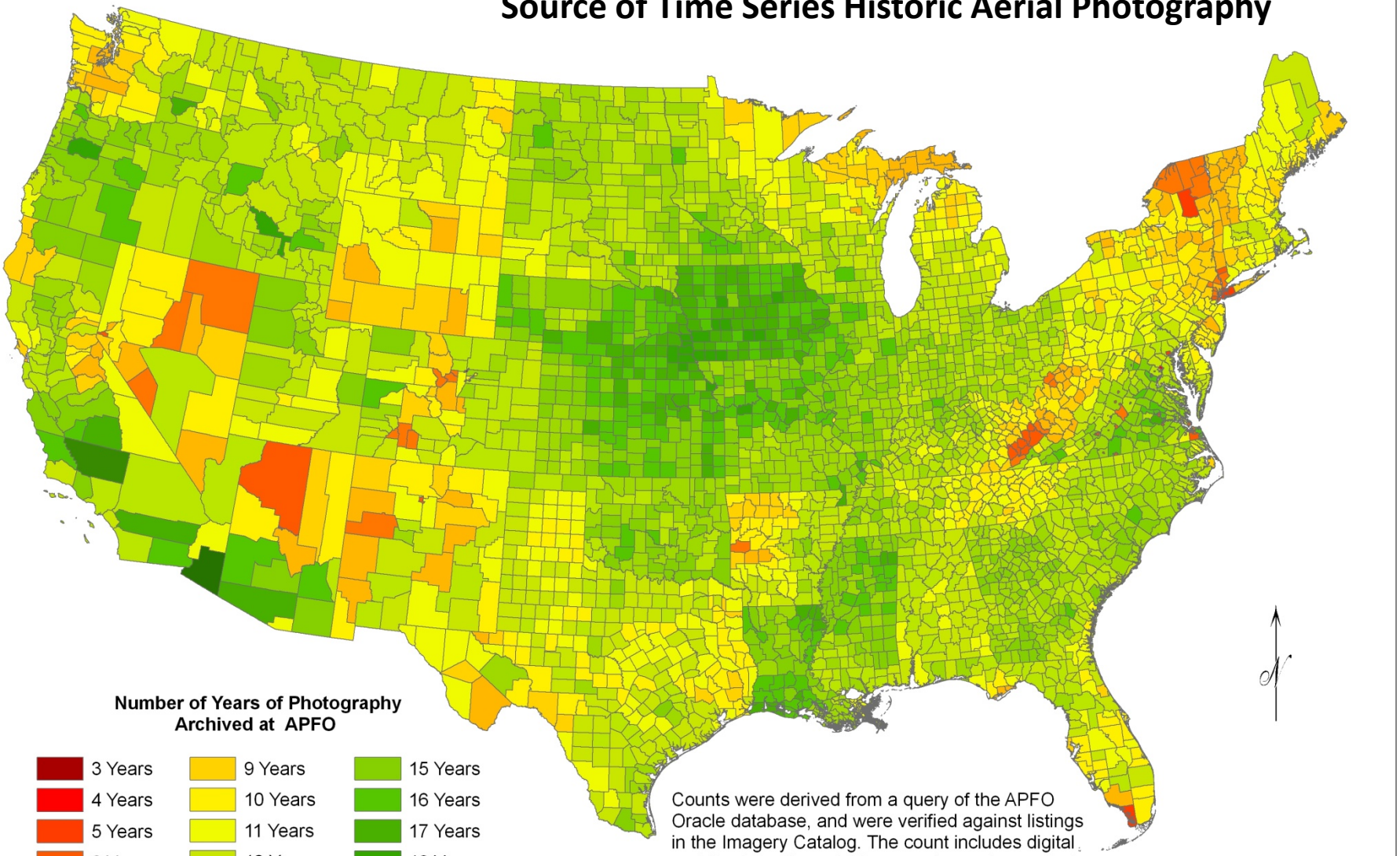
10 million film exposures

Also archived: NHAP, NAPP, NAIP

- USDA Agencies use the Aerial Photography Field Office for all major aerial photography contracts, quality control, and archive services.

Aerial Photography Products, Digital and Film-Based, at APFO

Source of Time Series Historic Aerial Photography



Counts were derived from a query of the APFO Oracle database, and were verified against listings in the Imagery Catalog. The count includes digital and film-based acquisitions; each year is counted only once. For example, NAPP film was used to create DOQQs. Both digital and film versions exist at APFO, but they are considered as only one year of imagery.

National Agriculture Imagery Program

Slide credits for NAIP section:

- Kent Williams
- John Mootz
- Jacque La Croix
- Michelle Clifford

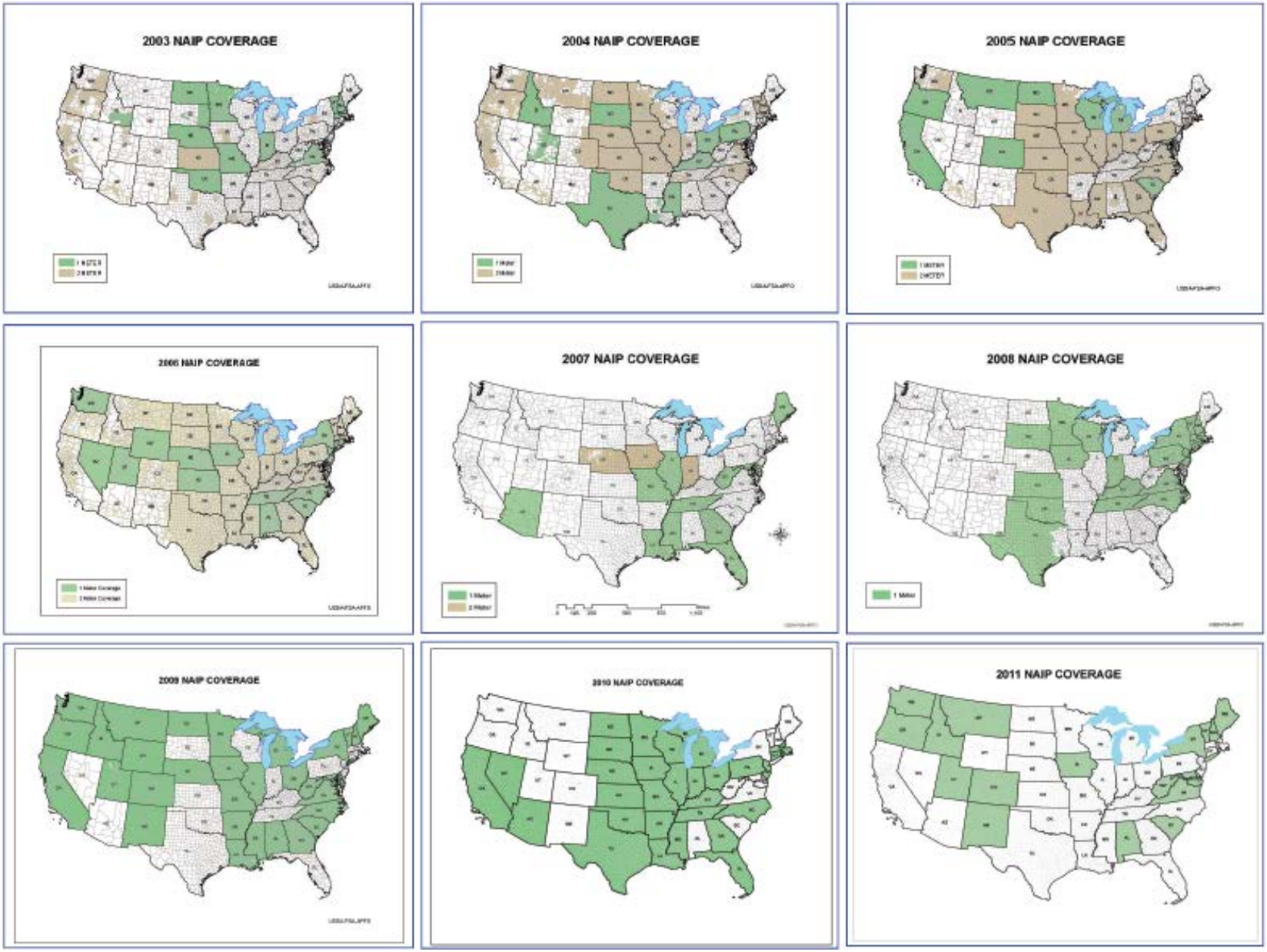
NAIP Is the Image Base Used To Interact with Our Nation's Farm Community

Current Ortho Image with Common Land Unit (CLU) Boundaries

Travis County, TX 2010

Integrates Geospatial and Tabular Data

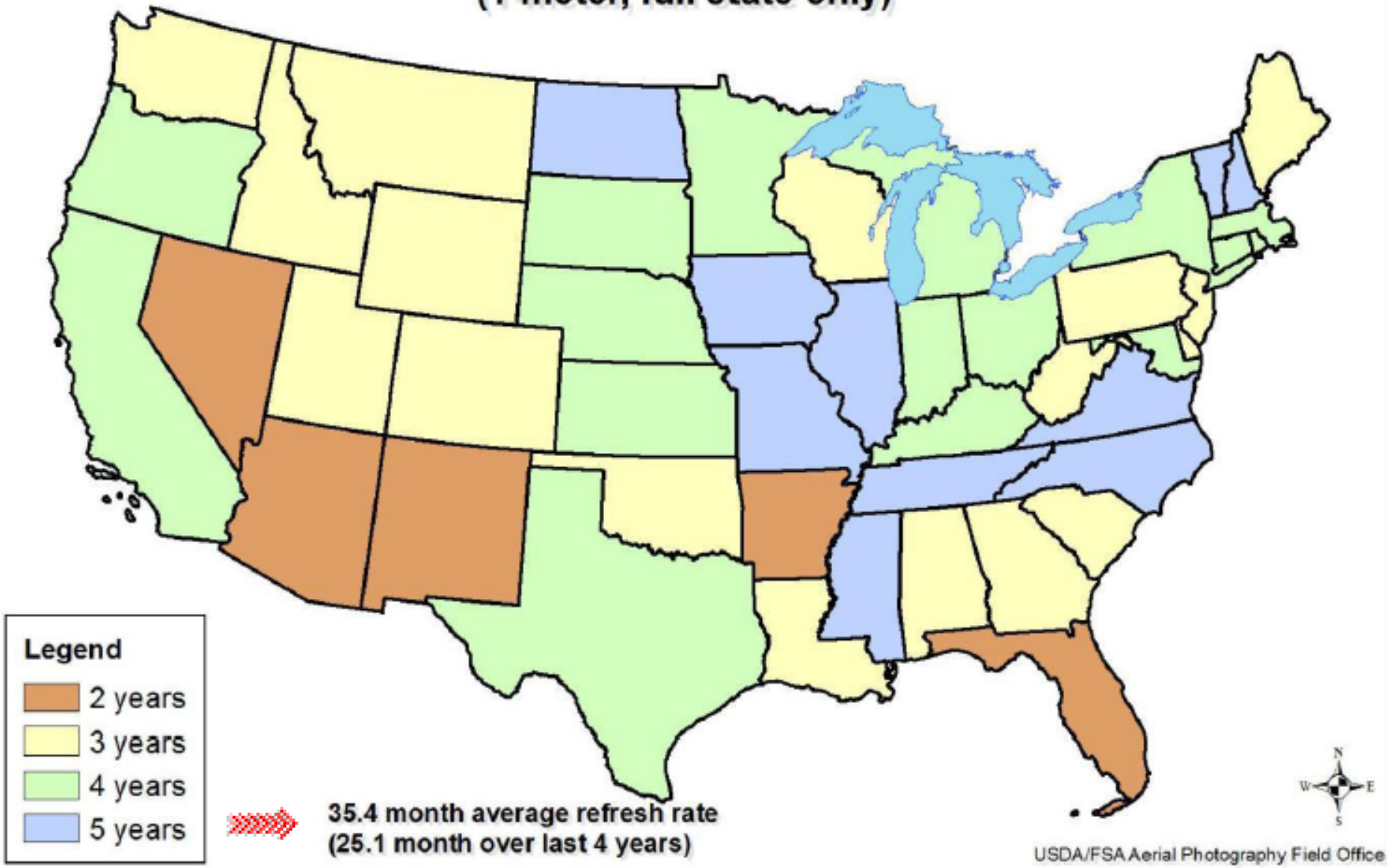
- Ownership
- Land use
- Acreage
- Crop History
- Conservation
- Easements



From 2003-2012 ,the National Agricultural Imagery Program (NAIP) has spent about $200 Million on Orthoimagery in support of agency programs.

2003-2012 NAIP

Number of years that imagery has been acquired
(1-meter, full state only)

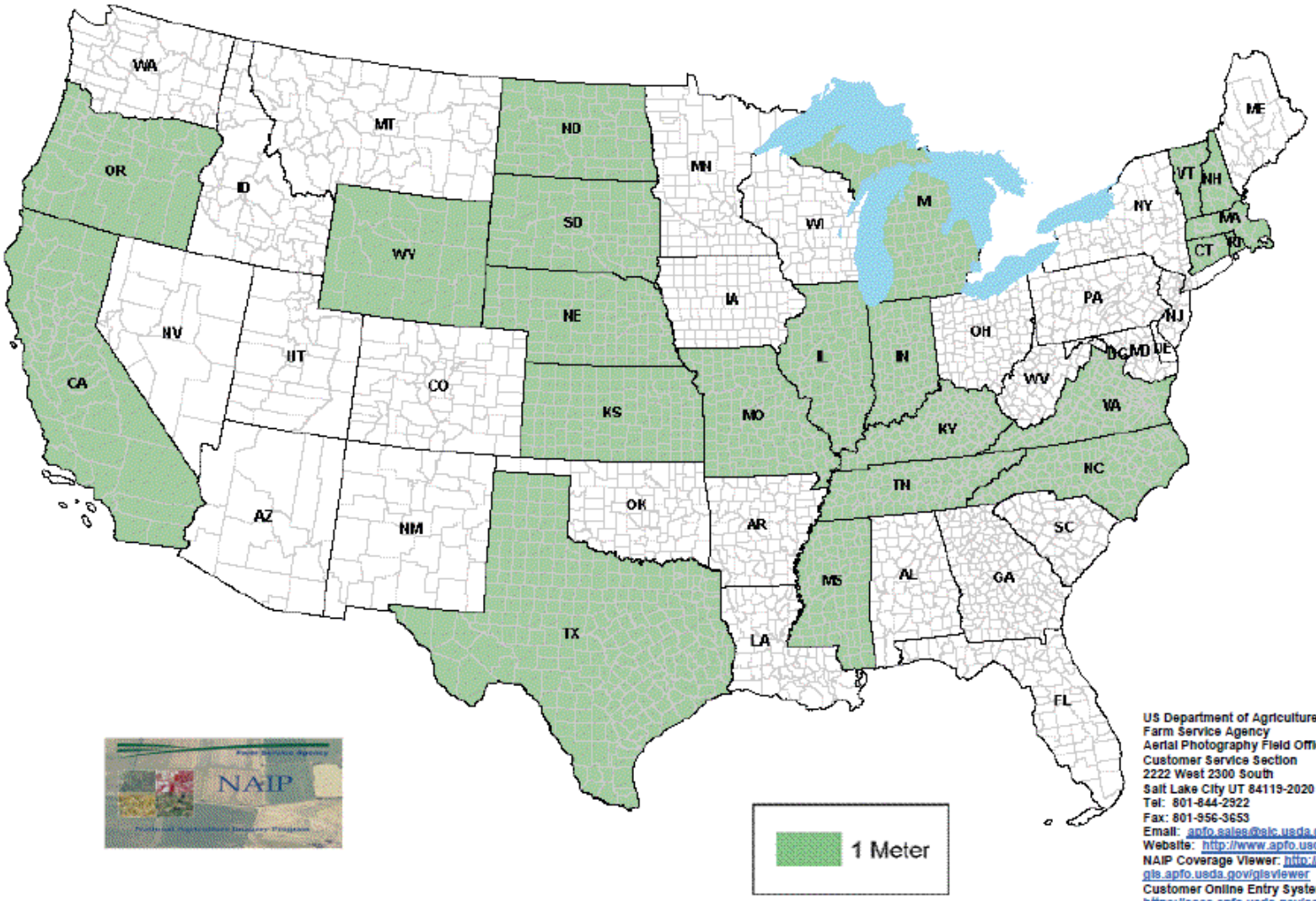


USDA

FSA FARM SERVICE AGENCY

APFO AERIAL PHOTOGRAPHY FIELD OFFICE

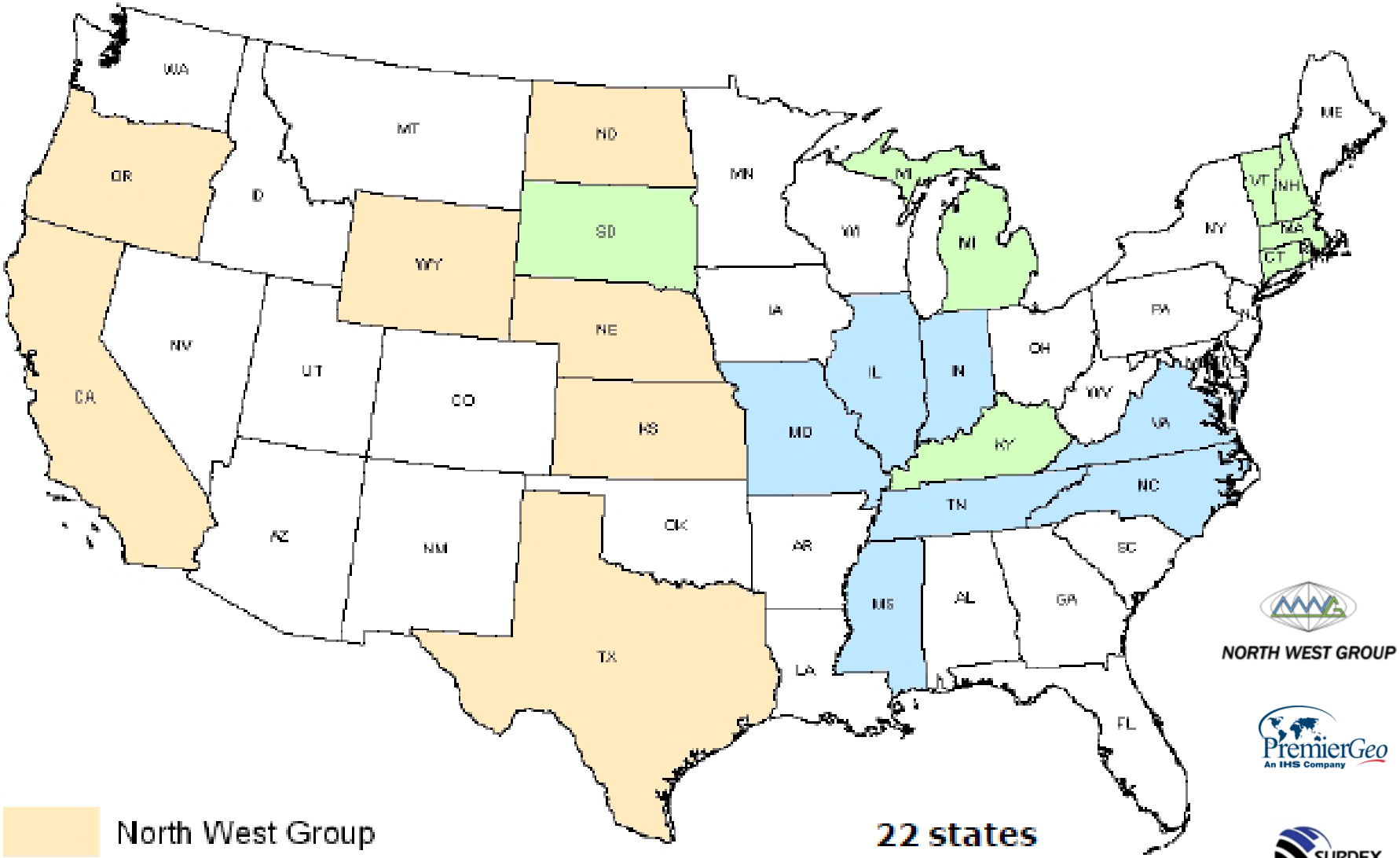
2012 NAIP COVERAGE



US Department of Agriculture
Farm Service Agency
Aerial Photography Field Office
Customer Service Section
2222 West 2300 South
Salt Lake City UT 84119-2020
Tel: 801-844-2922
Fax: 801-956-3653
Email: apfo.sales@slc.usda.gov
Website: http://www.apfo.usda.gov
NAIP Coverage Viewer: http://gis.apfo.usda.gov/gisviewer
Customer Online Entry System: https://coes.apfo.usda.gov/coe/search.jsp

USDA-FSA-APFO

2012 NAIP Contractors



North West Group

PremierGeo

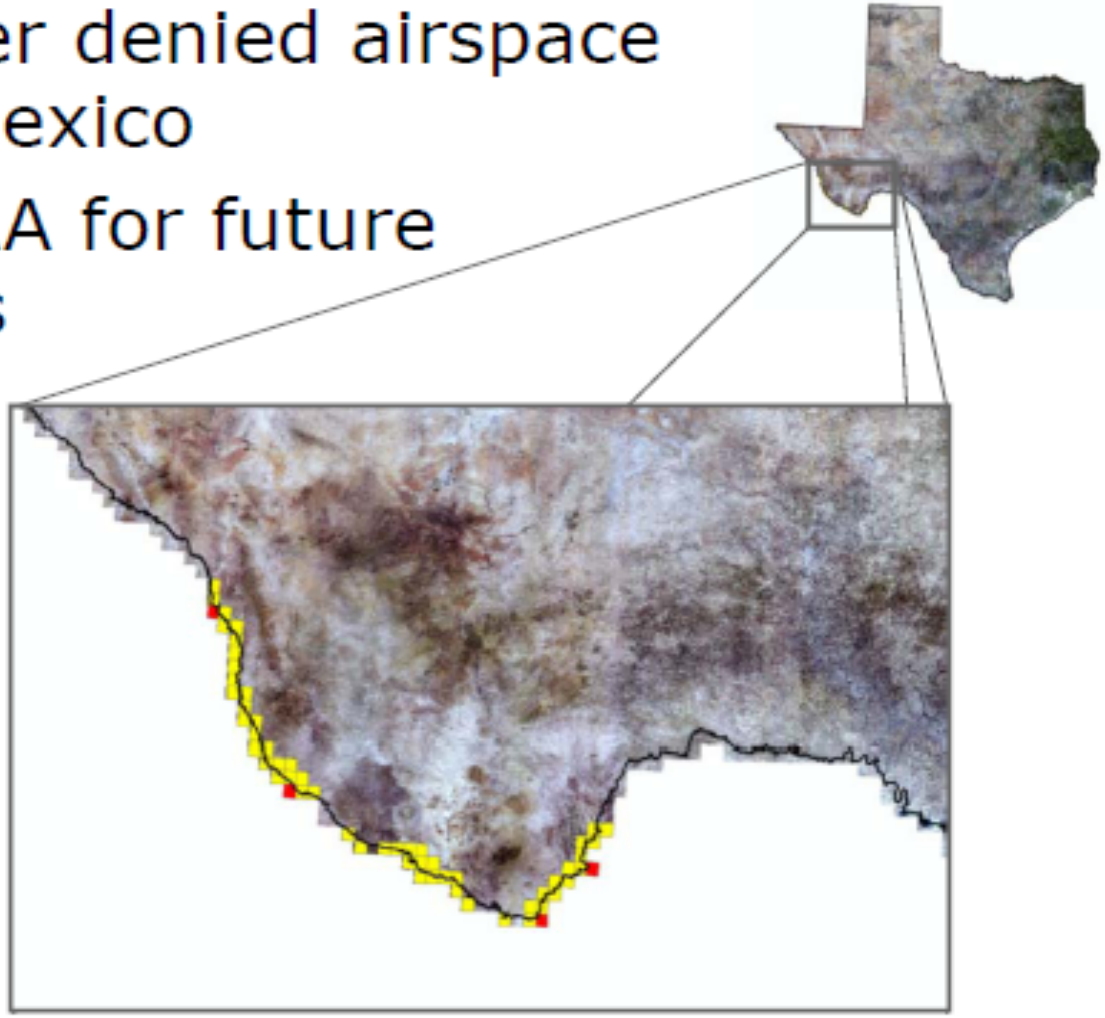
Surdex

22 states
101,754 DOQQs
1,471,553 sq miles

USDA-FSA-APFO

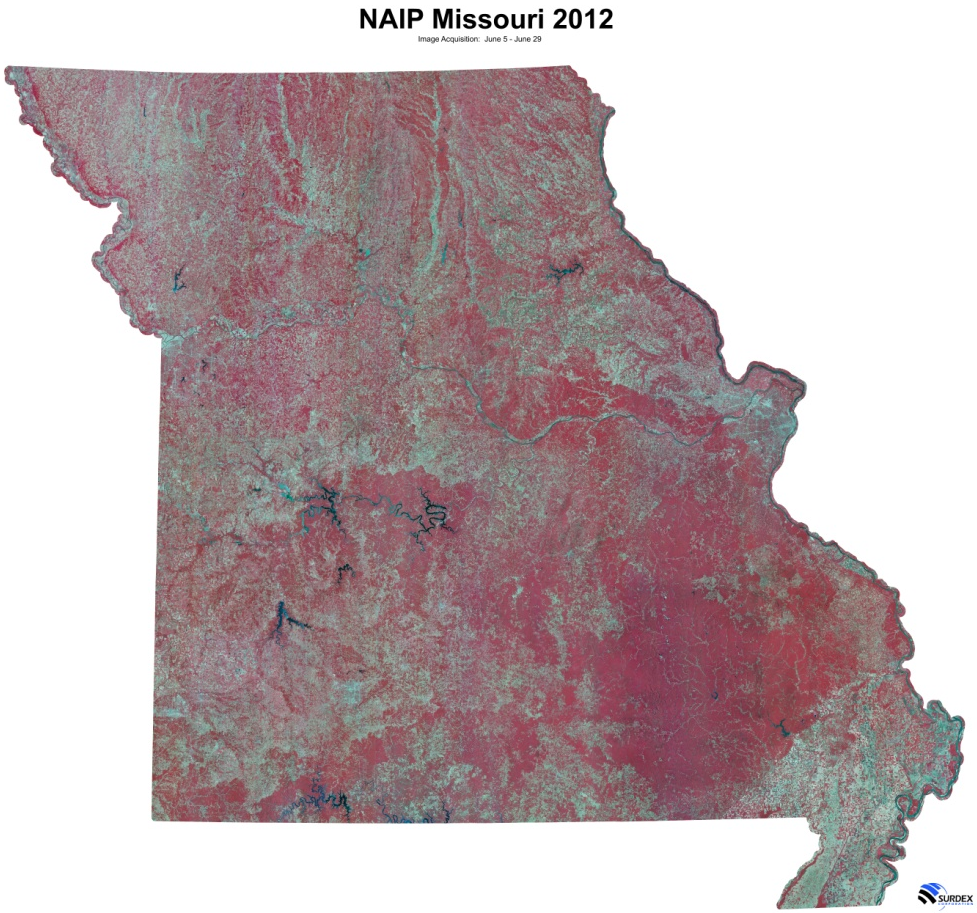
2012 NAIP: Only 4 of 101,754 DOQs not Acquired

- Monterrey Center denied airspace clearance into Mexico
- Working with FAA for future border crossings

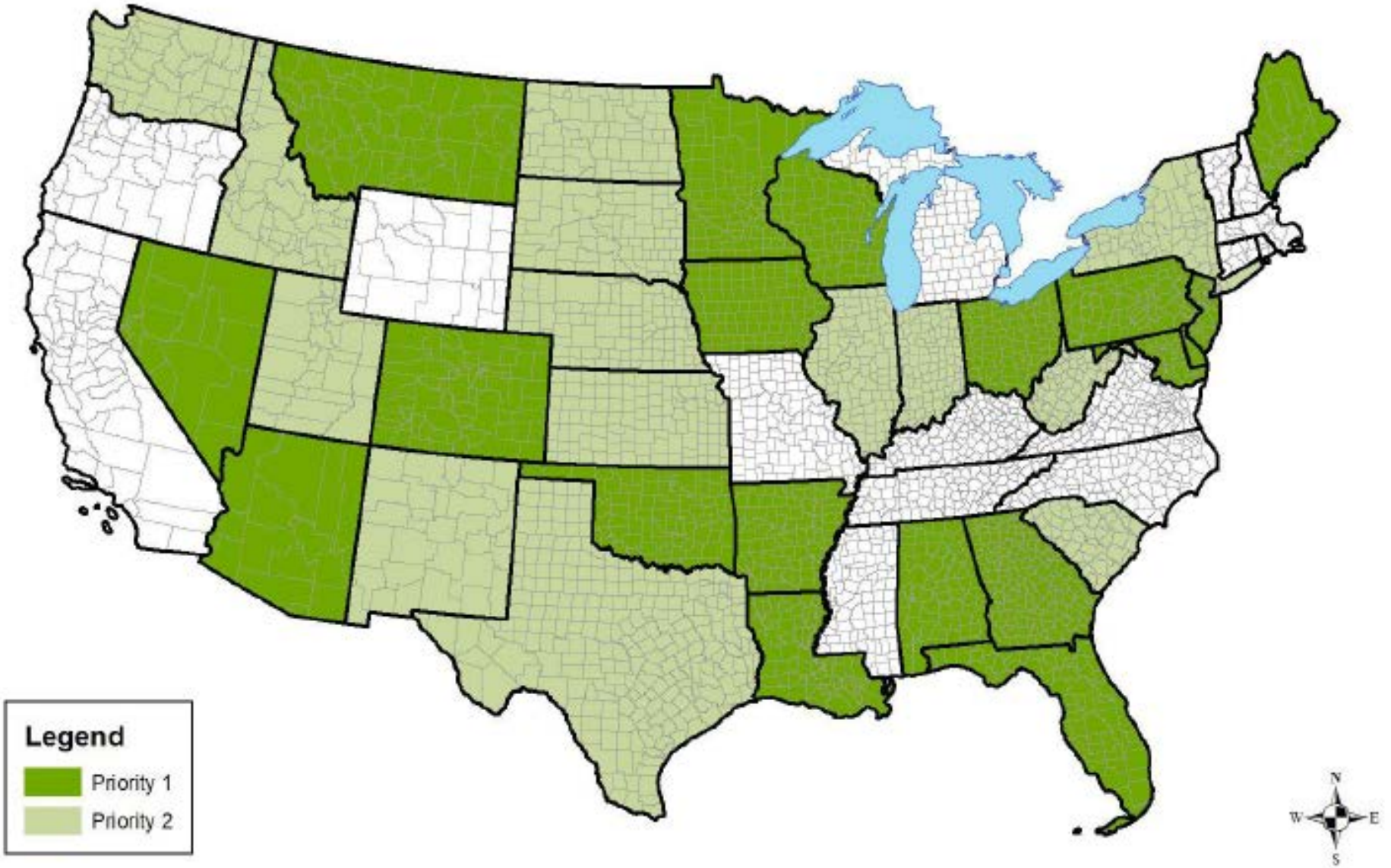


4 DOQQs not acquired and 55 partials

NAIP Finished Products:
Seamless Natural Color and CIR Mosaics



2013 NAIP Planned Acquisition



USDA/FSA Aerial Photography Field Office

2013 Task Order

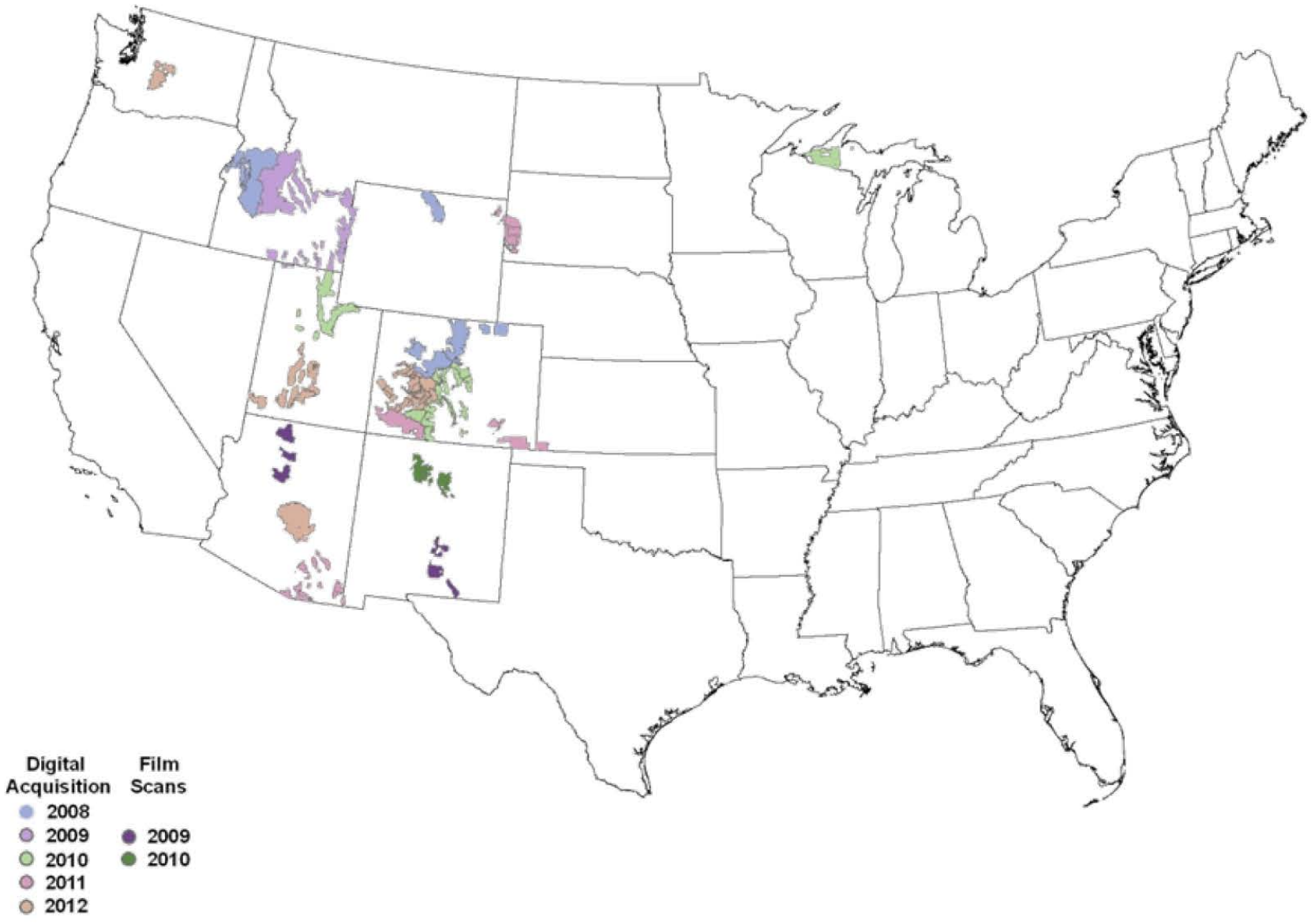
- Requirements
  - 4 Bands
  - 1 meter
  - DOQQ
  - Seamless County Mosaics
- Planned on 19 states; Actual Number TBD
- Discussions with few possible ½ meter
- Expect initial award within 2 weeks
  - Funds Available.
- Hoping for a second round of awards.
  - Subject to the availability of funds.

Forest Service Resource Photography

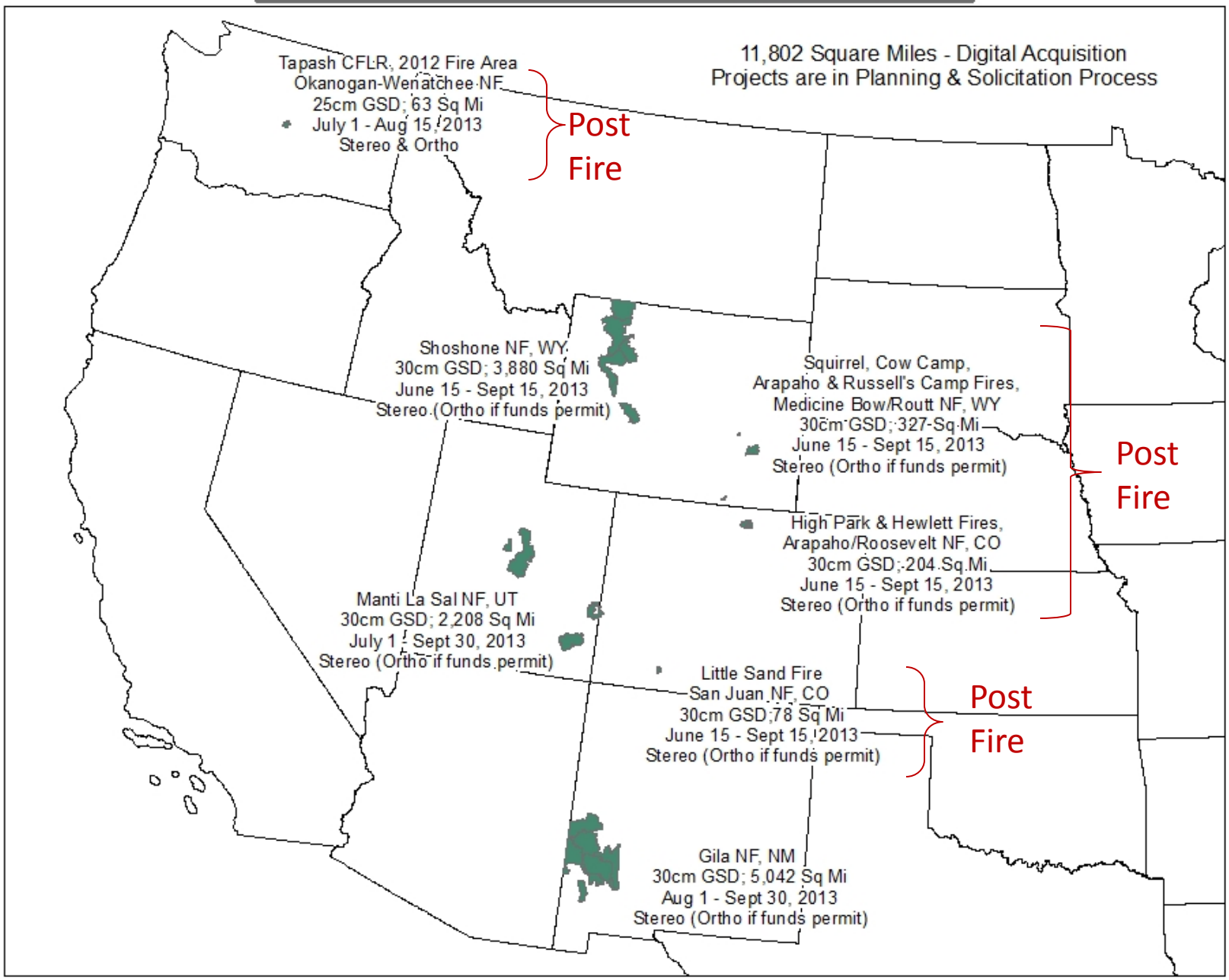
- Digital imagery allows meet multiple requirements to be satisfied with the same acquisition.
- High Spatial Resolution
  - (25cm to 50cm)
- Ortho image base updates as a contract option
- 4-band, 16-bit imagery exploitation
- Stereo
- Cover Extent of Forest Service Land or Extent of Fire Event

6,964 Square Miles
13,018 Stereo Images
13,018 Ortho Images

Digital Resource Imagery



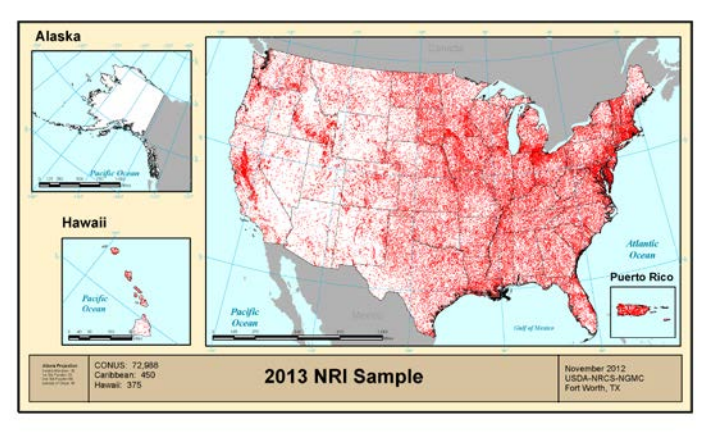
2013 Resource Aerial Imagery Projects



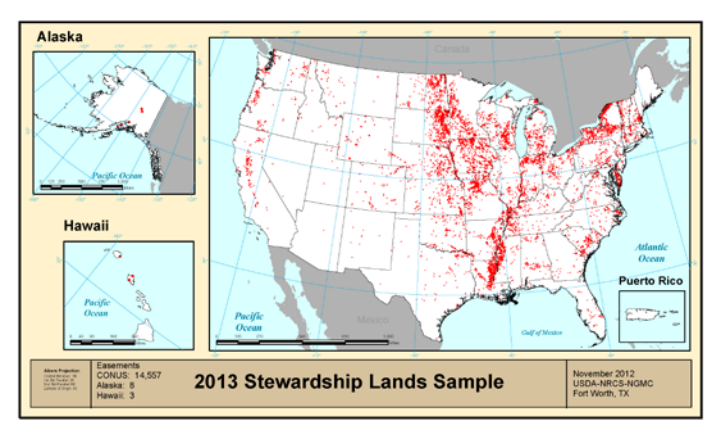
25-30 cm GSD Digital 4 band Collections: Deliveries of Orthophotos and Stereo Coverage

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

National Resource Inventory (NRI) :
A statistical survey of land use and natural resource conditions and trends on U.S. non-Federal lands.

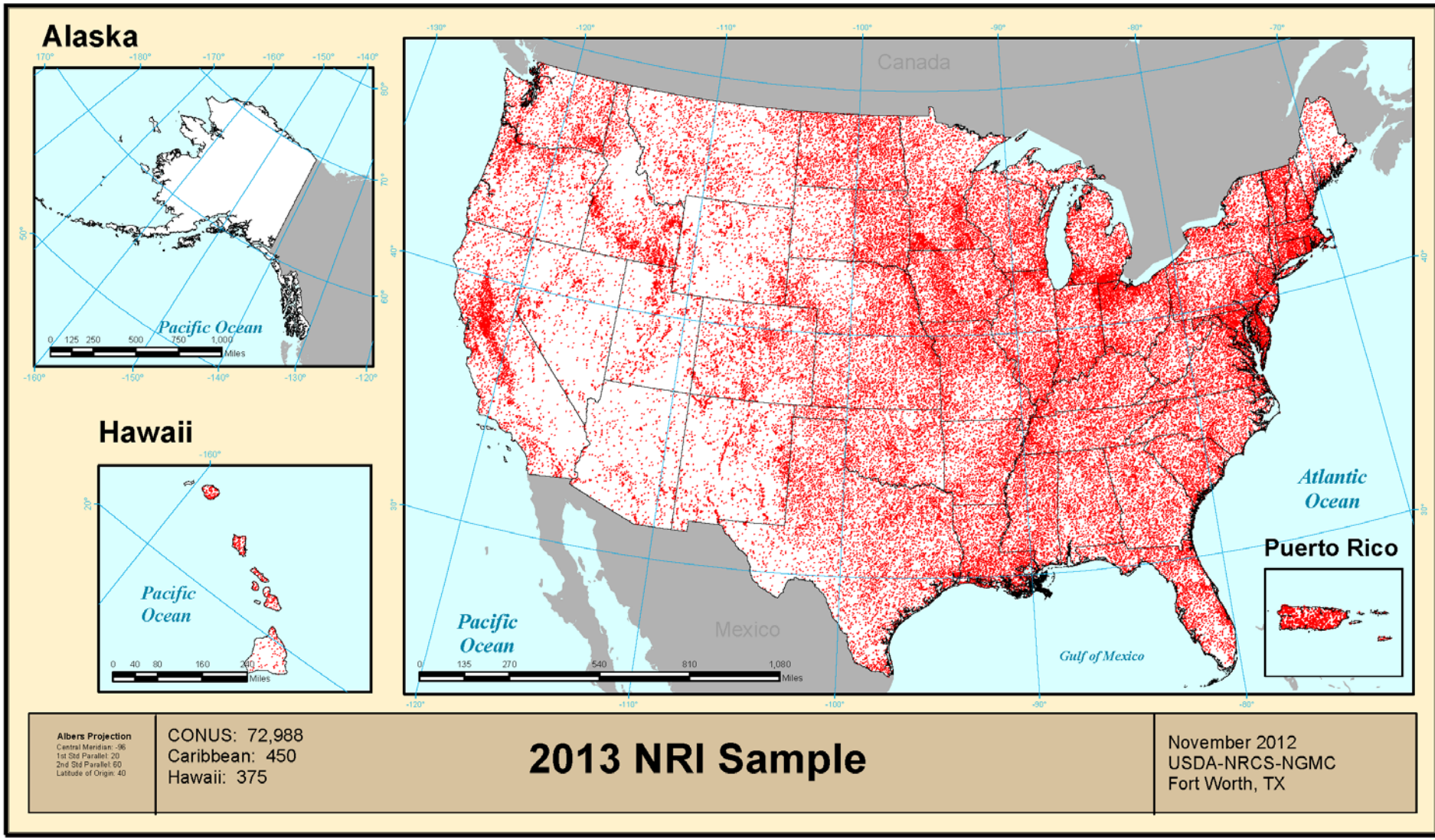


Stewardship Lands Imagery:
Used for Conservation Easement Compliance

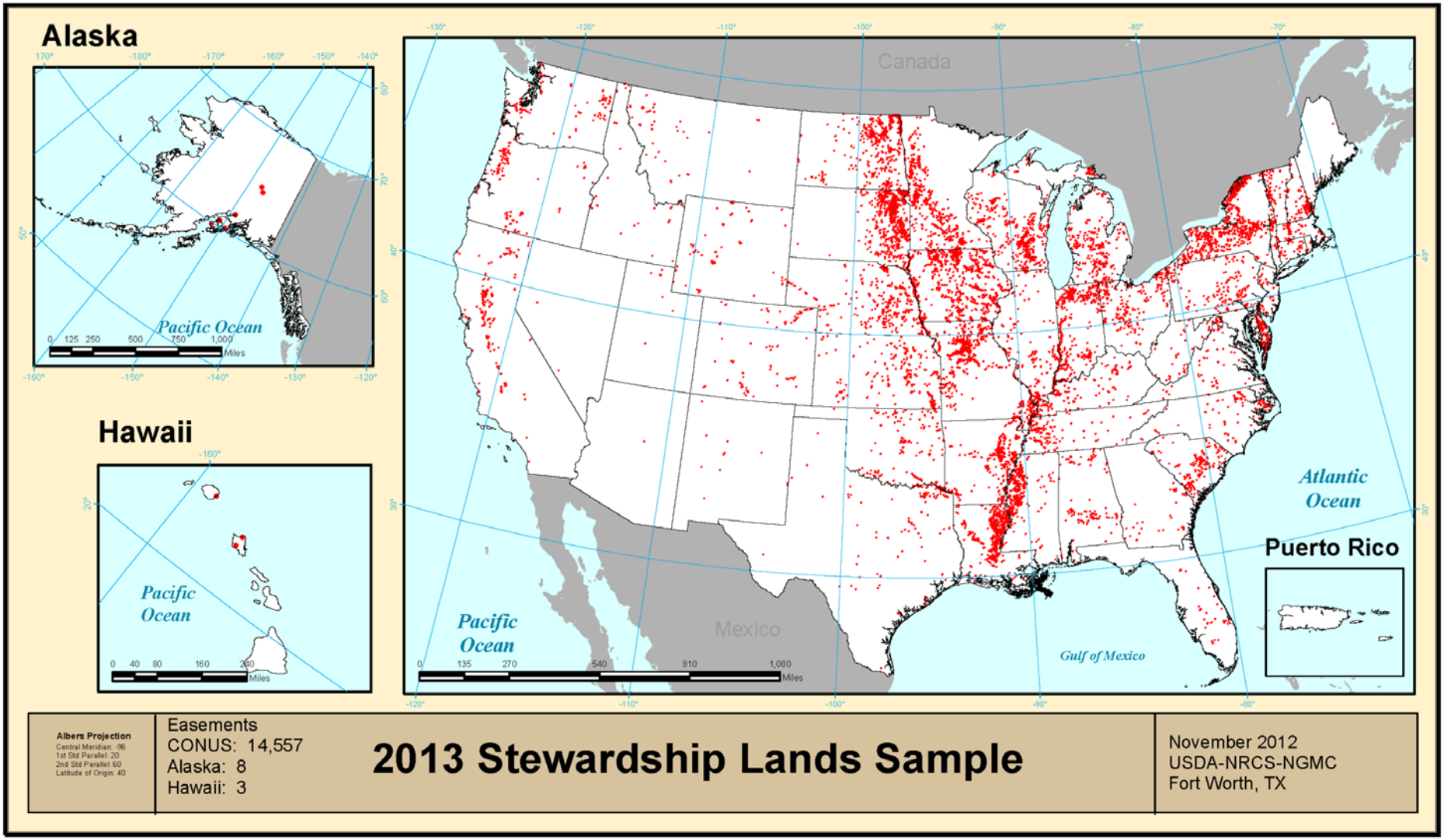


National Resource Inventory (NRI) and Stewardship Lands Imagery

- Contracts Awarded April 3, 2013.
- 9x9 color film
- Scans Part of deliverable
- Photo segment centered with GPS
- Acquired at a contact scale of 1:7,920 (1 inch = 660 feet) with a resolution of 0.15 meters.

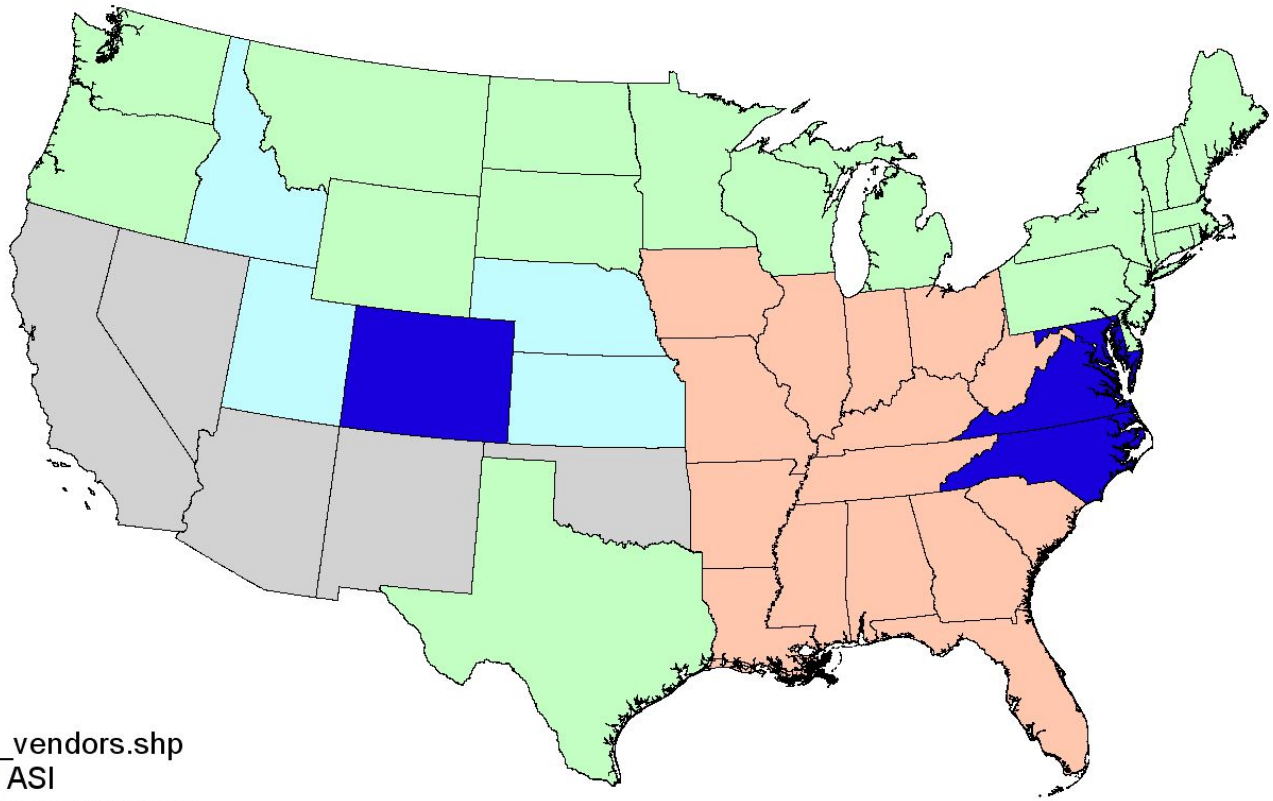


72,988 CONUS, 450 Caribbean, 375 Hawaii



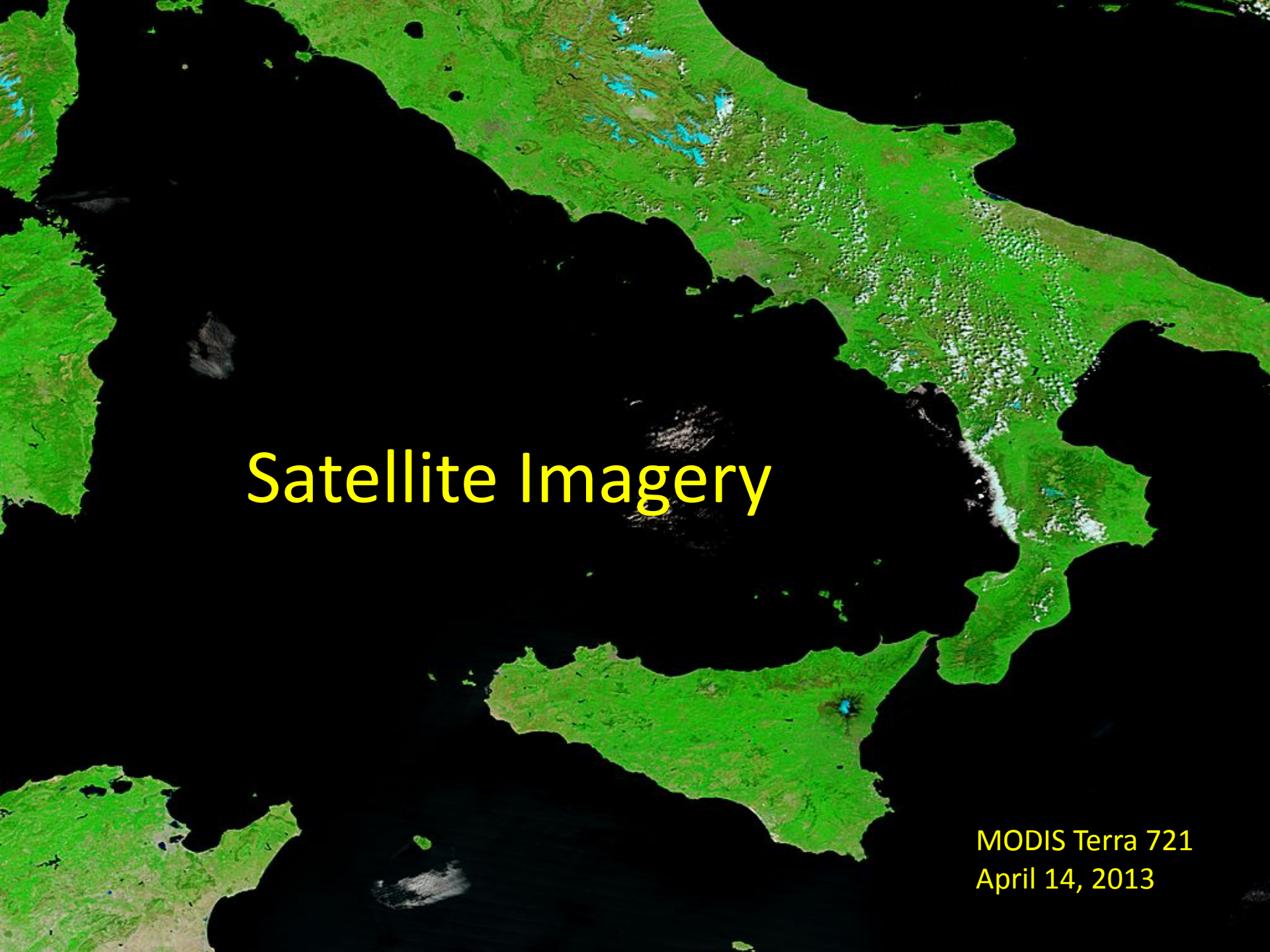
14,557 CONUS, 8 Alaska, 3 Hawaii

2013 NRI/SLI Vendors



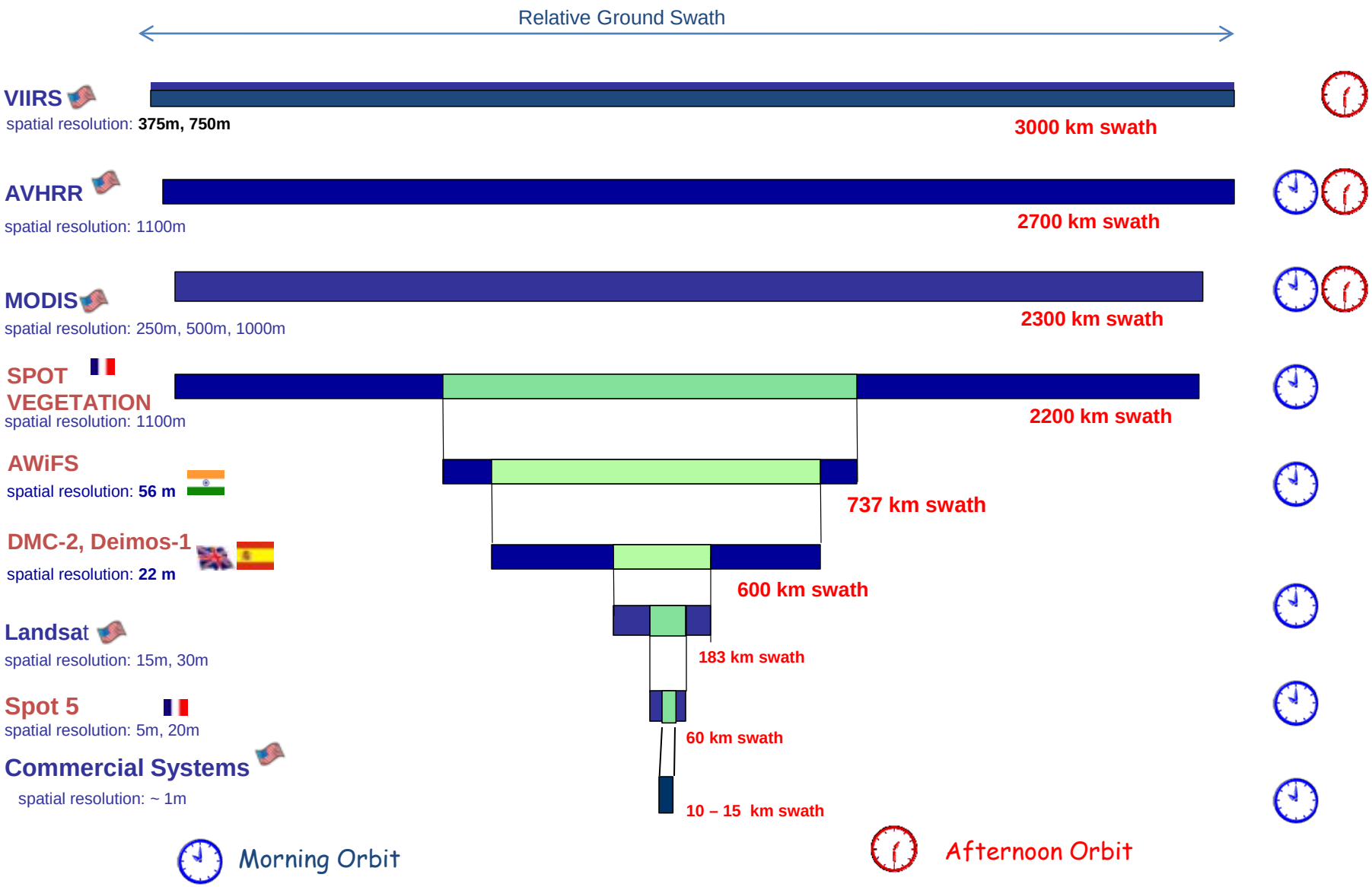
2013_vendors.shp
- ASI
- AeroGraphics
- Blue Skies
- Keystone
- Rocky Mtn

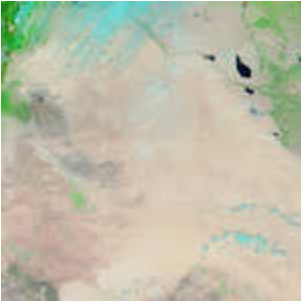
Satellite Imagery



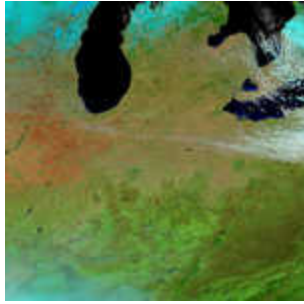
MODIS Terra 721
April 14, 2013

USDA Agricultural Monitoring Satellites

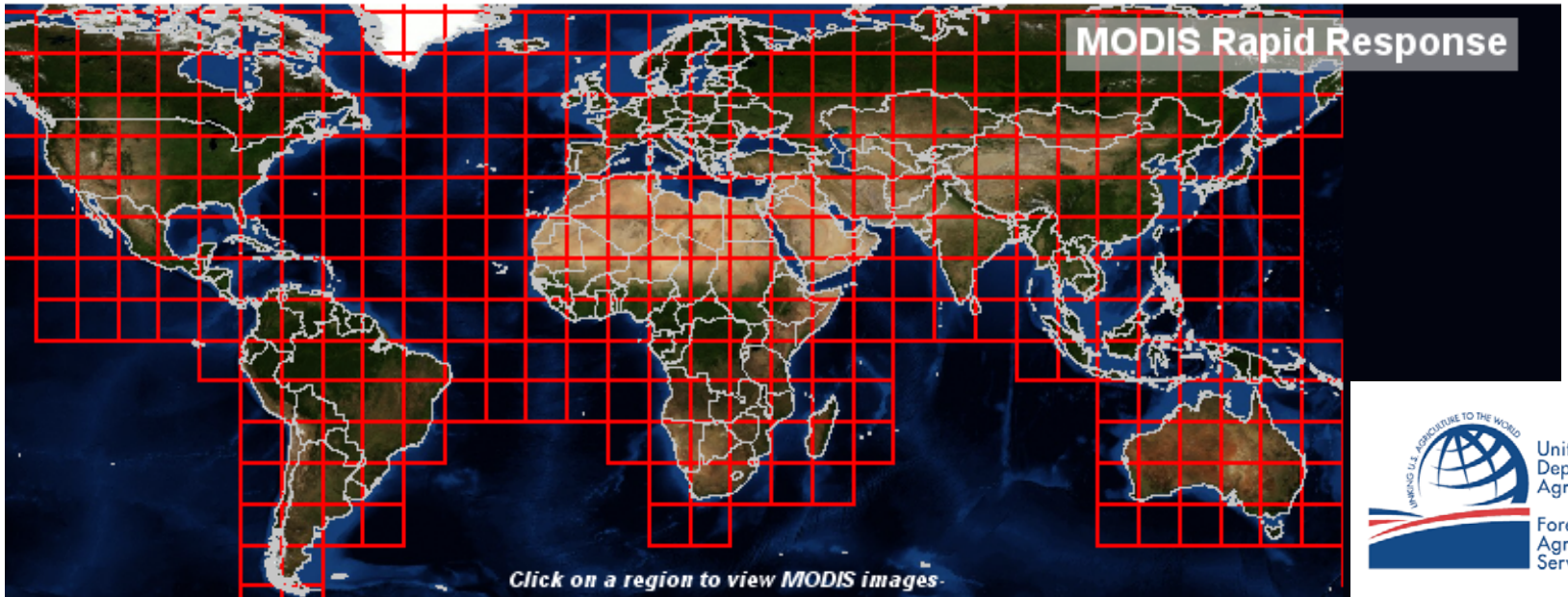




MODIS Is A Key Resource

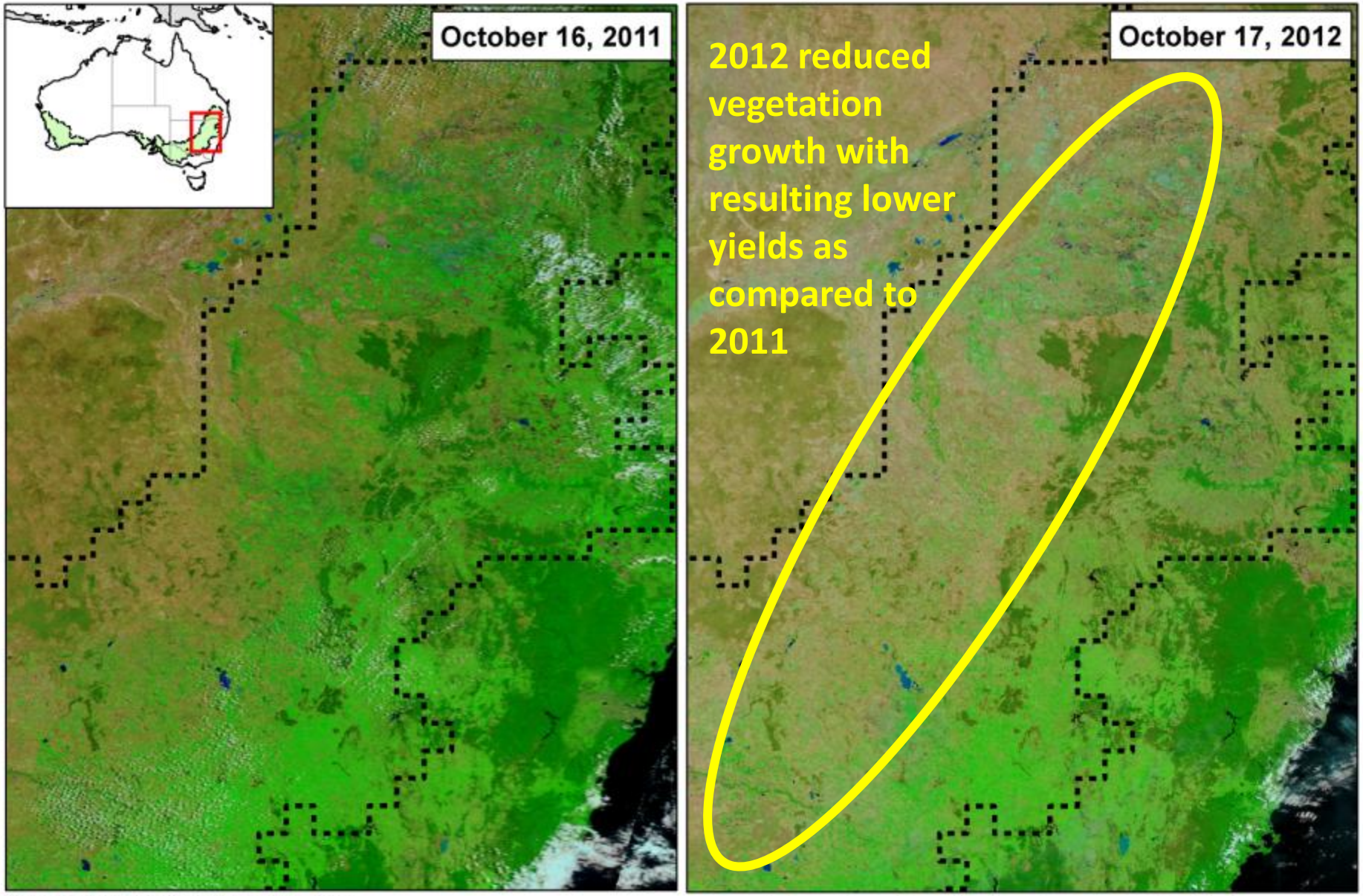


- Foreign Agriculture Service (FAS) Processes and posts **Daily** Terra and Aqua MODIS for Global Crop Conditions. Terra is preferred over Aqua.
- Time Series Analysis
  http://www.pecad.fas.usda.gov/cropexplorer/modis_summary/
  http://www.pecad.fas.usda.gov/cropexplorer/



United States Department of Agriculture
Foreign Agricultural Service

MODIS 7-2-1 Comparison of Wheat Belt, New South Wales, Australia



Source: MODIS 7-2-1 Composite, Crop Explorer/MODIS Rapid Response

Wheat Cultivation

N

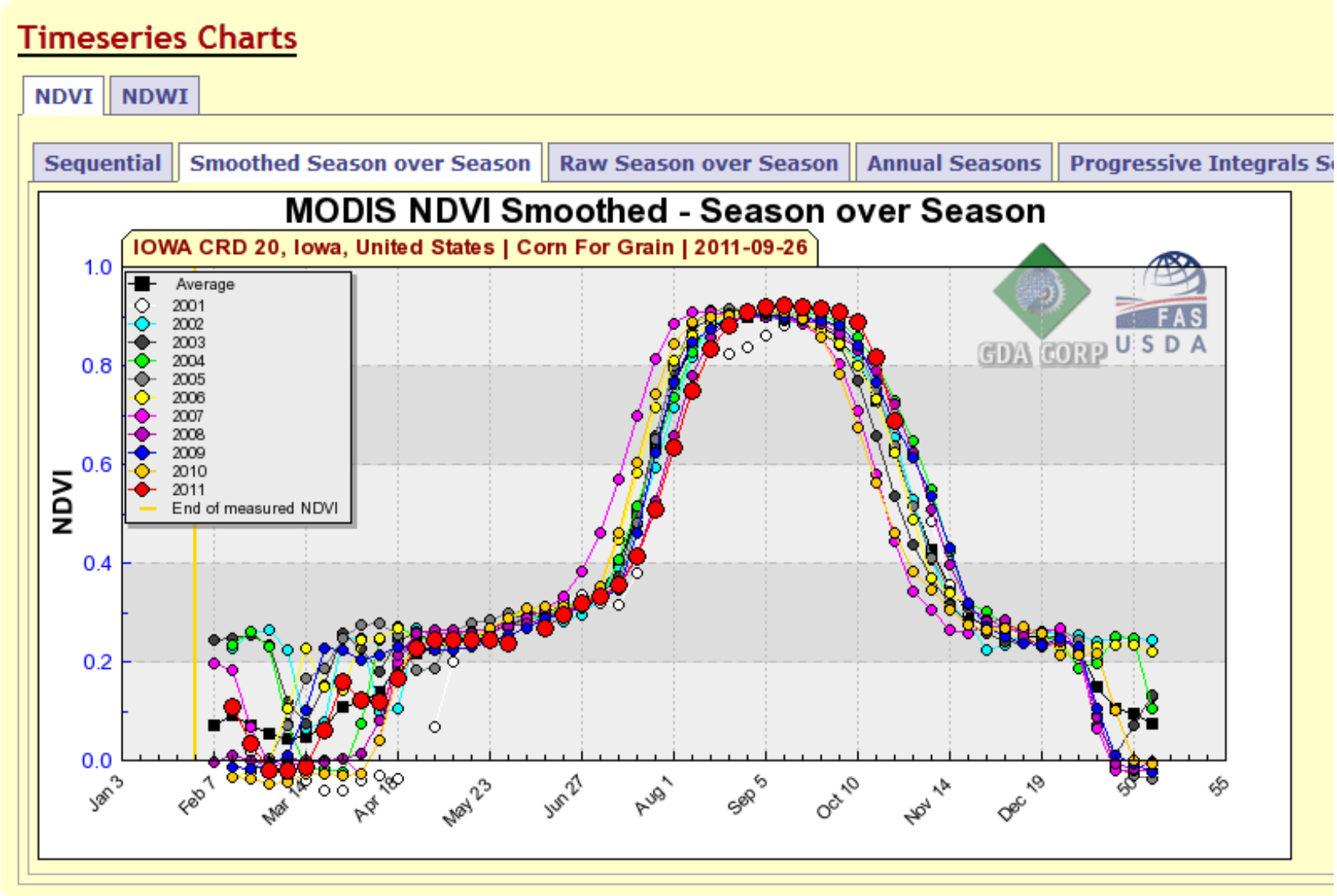
0 50 100 200 km

International Production Assessment Division
Office of Global Analysis
Foreign Agriculture Service
U.S. Department of Agriculture

FAS USDA

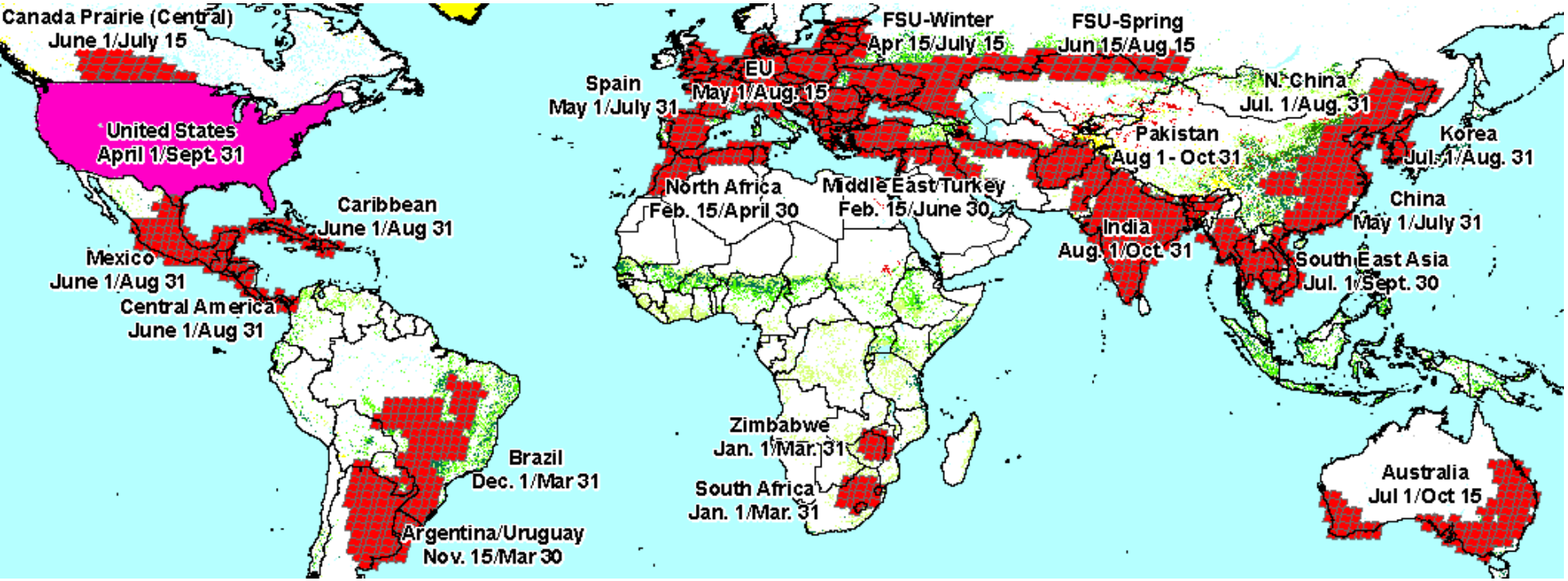
November 9, 2012

Time Series Charts: NDVI for Crop Reporting District 20 in Iowa, Magnitude relates to Corn Yield



Slide Credit: GDA Corporation

International Landsat-5/7 Downloads For Crop Condition and Crop Forecasting



- The Foreign Agricultural Service (FAS) Downloads all Landsat-5/7 with <30% clouds
- Pre-Landsat 5 failure, Used Landsat 7 SLC off during 2012.
- These areas will be downloaded once Landsat 8 is operational

United States Department of Agriculture
Foreign Agricultural Service

FY12 Imagery Acquisitions by USDA' s Satellite Imagery Archive (SIA)

USDA Foreign Agricultural Service with contributions from the USDA SIA members supported two satellite imagery contracts with ***four satellites*** covering the US:

a) (22-meter) imagery via USDA/FAS and SPOT-Astrium contract:

- April 7-*November 30, 2012*.

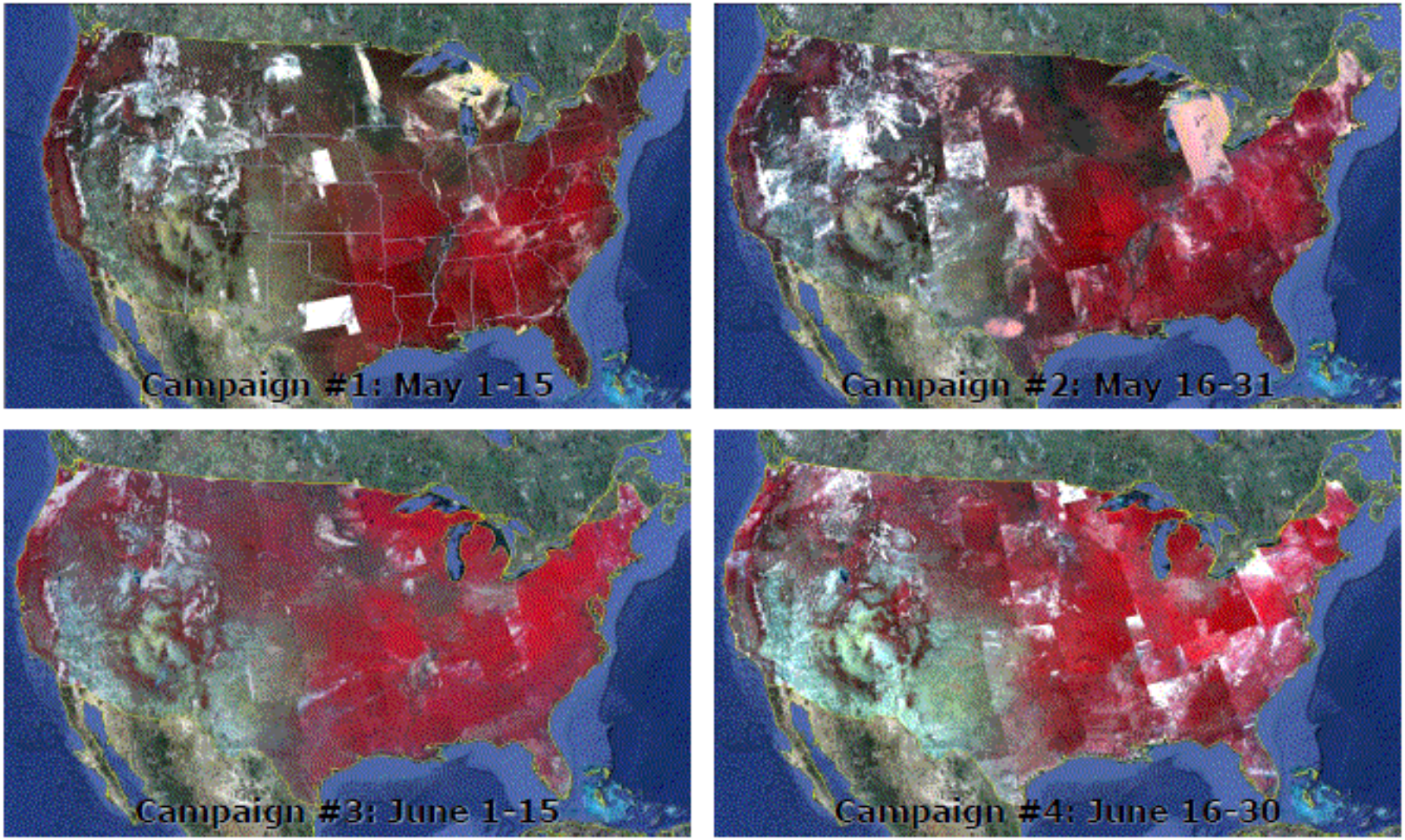
b) ***SPOT 4*** (20-meter) & ***SPOT-5*** (10-meter) imagery via USGS-SPOT North America Data Buy (NADB) contract.

- December 26, 2011- *January 31, 2013*
- Cost-share with USGS.

United States Department of Agriculture
Foreign Agricultural Service

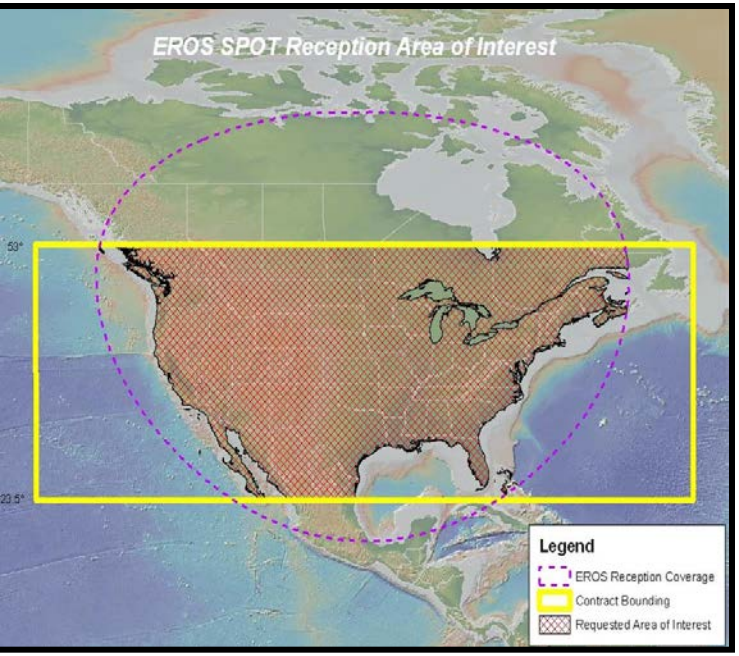
Deimos-1 & *UK-DMC2*

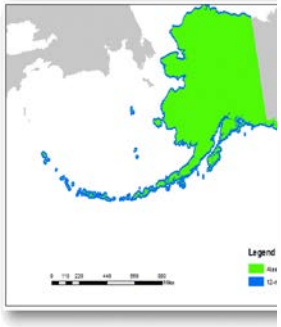
- Example of bimonthly (May-June) coverage mosaics

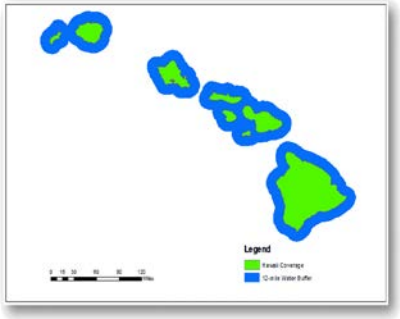


Licensed to USDA Agencies Only

SPOT/USGS-North American Data Buy (NADB) ends on January 31, 2013







- **Working on FY13 SPOT-NADB contract to begin on February 1, 2013.**
  - **FY13 contract could be the last SPOT-NADB contract after Landsat-8 is launched in 2013.**

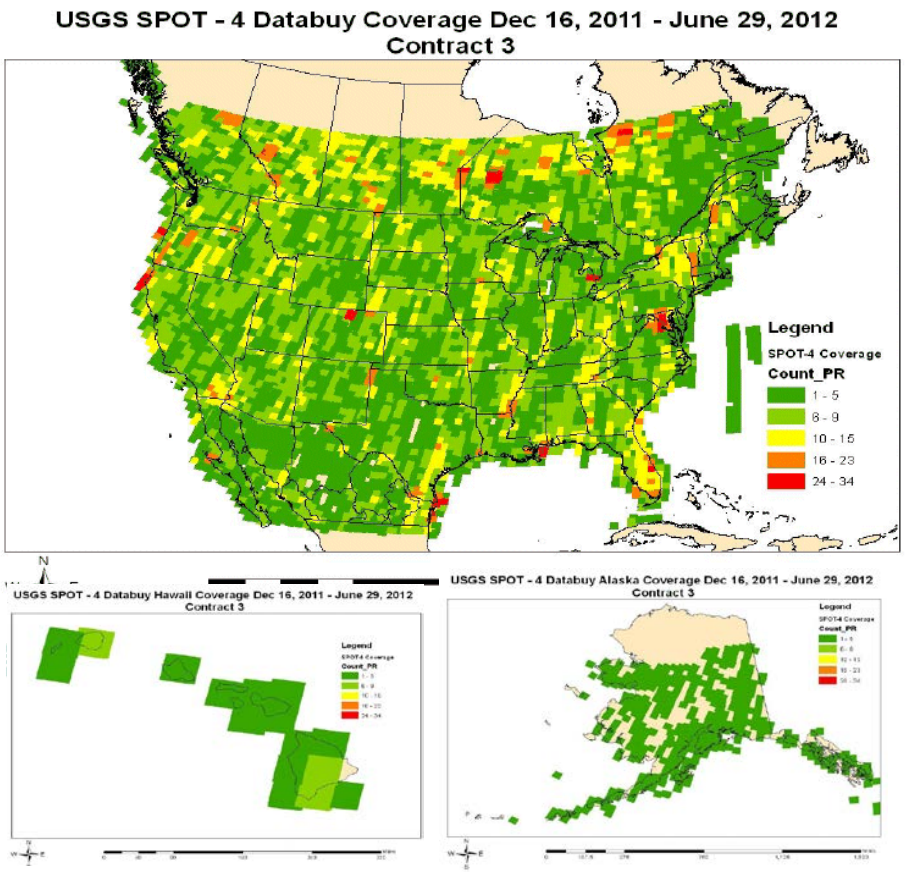
SPOT Images Received by USGS/NADB project

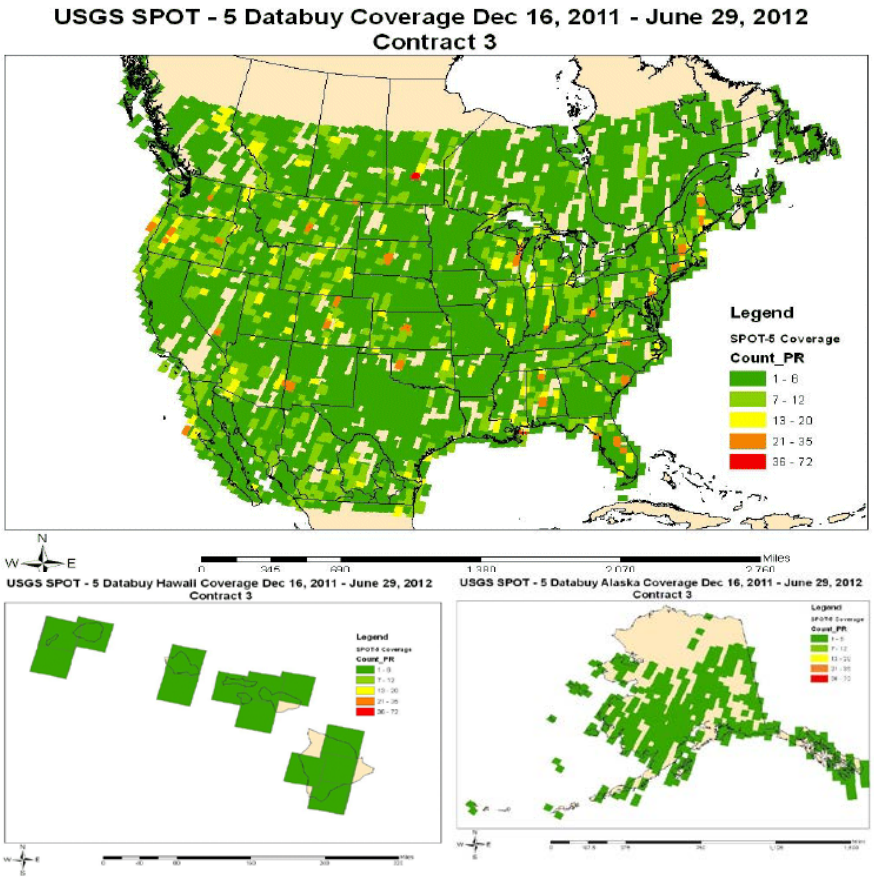
	Scenes Collected		Catalogue Price Value**		
~Year	SPOT4	SPOT5	SPOT4	SPOT5	Total
2010	38,770	28,117	$93,048,000	$120,200,175	$213,248,175
2011	44,805	35,884	$107,532,000	$153,404,100	$260,936,100
2012*	49,825	28,933	$119,580,000	$123,688,575	$243,268,575
Total	133,400	92,934	$320,160,000	$397,292,850	$717,452,850

* through October 31, 2012

**Level 3A (orthorectified catalogue price): SPOT4= $2400/scene and SPOT5=$4275/scene

SPOT-NADB Contract 3
(Dec 16, 2011- June 29, 2012)

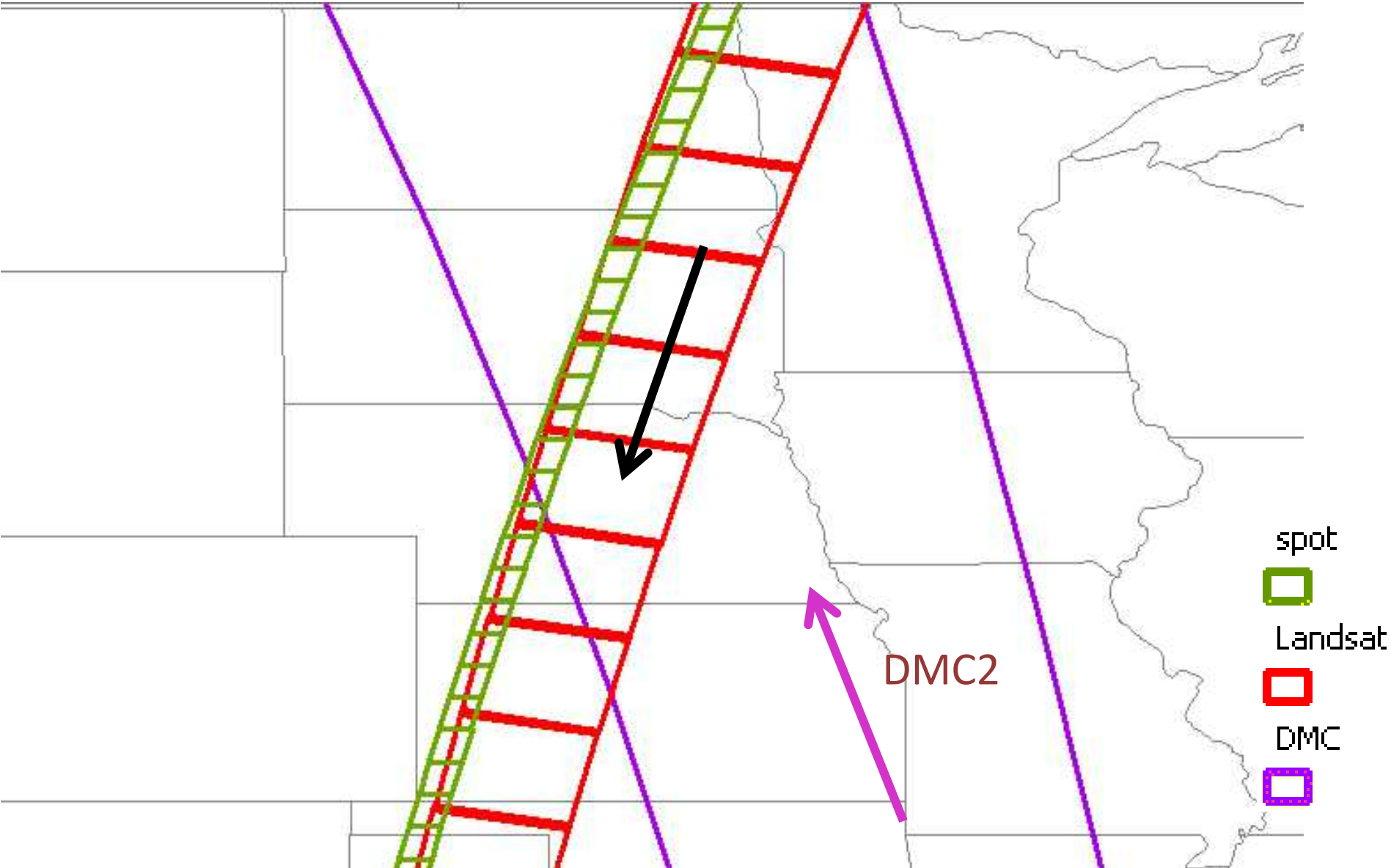




NADB 3-year Total = 133,400 SPOT4 + 92,923 SPOT5 scenes

Available to Federal Civil users from EarthExplorer http://earthexplorer.usgs.gov/

DMC2, SPOT, and Landsat Swaths:
Wide Swaths are better for Monitoring and Classification



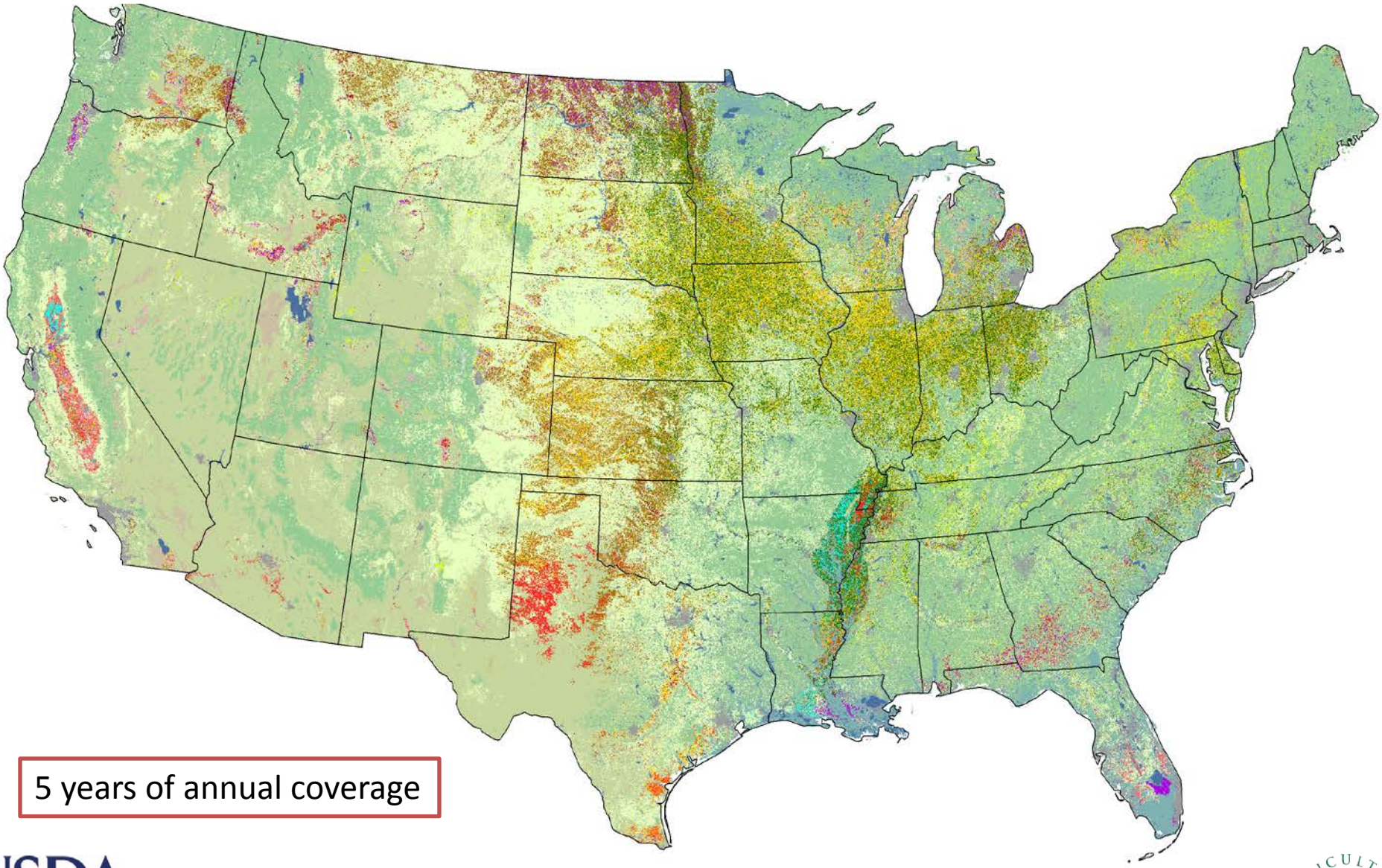
Jeff Zimmerman, Bob Tetrault (USDA FAS), and Igor Pezzini (Grupo André Maggi) reviewing 2013 Brazil soybeans near Querencia.

Sources: AWiFS (56 meter) imagery in false color bands 3 (NIR), 4 (SWIR), 2 (Red), December 24, 2012; Air Force Weather Agency (AFWA) LIS Grid, ~27 sq. km; and GPS data.

Linking U.S. Agriculture FAS to the World

Slide Credit: Robert Tetrault

2008 – 2012 National Cropland Data Layers



5 years of annual coverage

National Agricultural Statistics Service (NASS) Cropland Data Layer (CDL)

- Relies on federal cooperative partnerships
  - USDA/Farm Service Agency's Common Land Unit
  - USDA/Foreign Agricultural Service (FAS) Satellite Imaging Archive (SIA)
  - US Geological Survey (USGS) National Land Cover Dataset

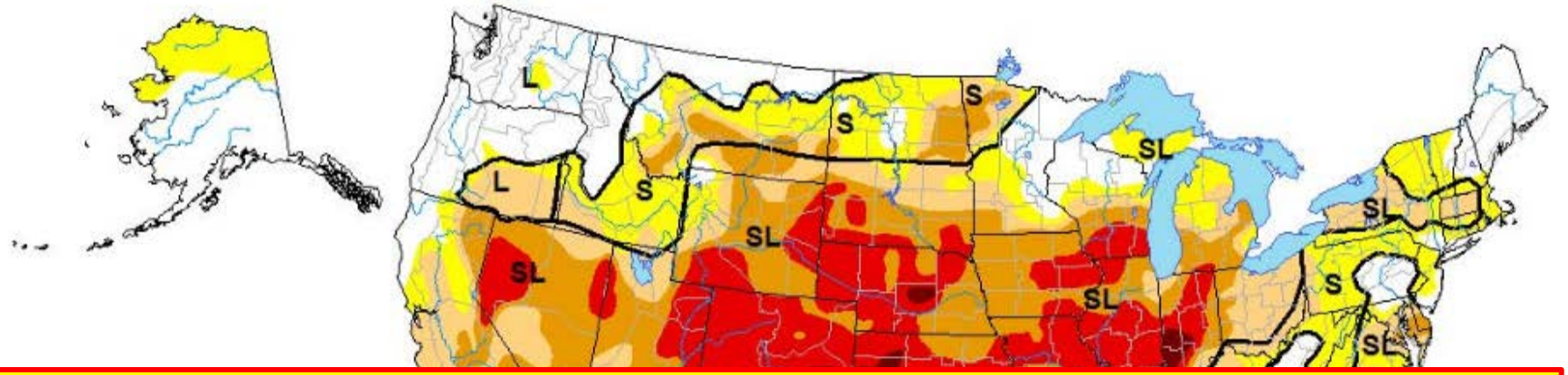
- The CDL delivers acreage indications internally for NASS to use as an independent unbiased measure of crop area

- In 2011 and 2012, the CDL program used both **DMC and USGS Landsat** data to produce **crop acreage estimates for crops at the state and county levels for 41 states for both the 2011 and 2012** crop years, up from 36 states in 2010

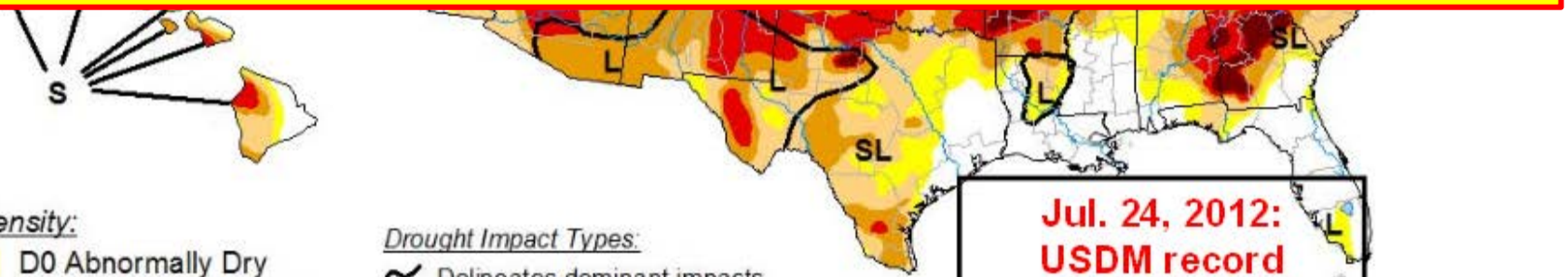
- With the expanded satellite coverage and timeliness, NASS was able to utilize the remote sensing acreage indications as independent input for setting the official estimates for the monthly Crop Production Reports

U.S. Drought Monitor

July 24, 2012
Valid 7 a.m. EDT



Crop year 2012 was a major challenge with a historical drought and without Landsat imagery
<u>However DMCii provided the solution to our agricultural monitoring problem!</u>



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:
Delineates dominant impacts
S = Short-Term, typically <6 months (e.g. agriculture, grasslands)
L = Long-Term, typically >6 months (e.g. hydrology, ecology)

Jul. 24, 2012: USDM record with 63.86% of CONUS in drought.

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

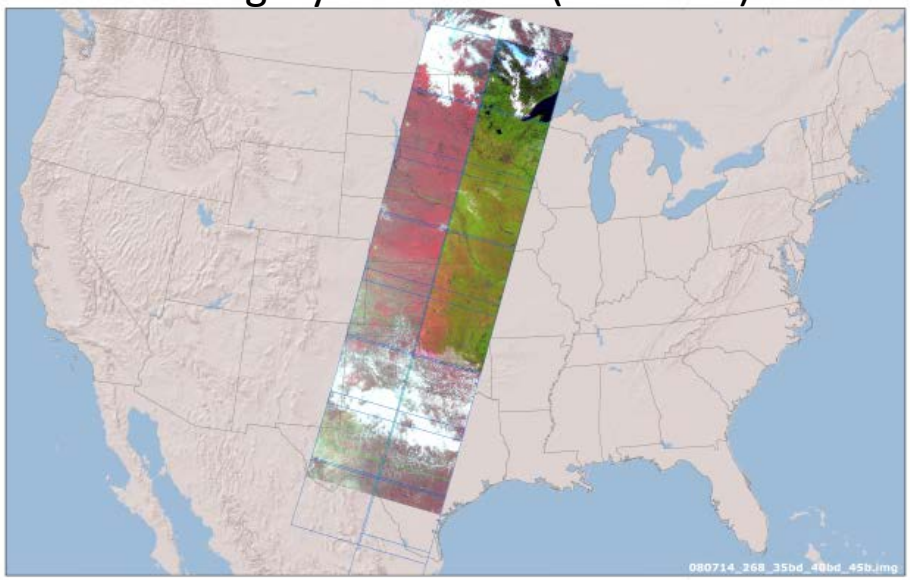
http://droughtmonitor.unl.edu/

Released Thursday, July 26, 2012
Author: Richard Heim NOAA/NESDIS/NCDC

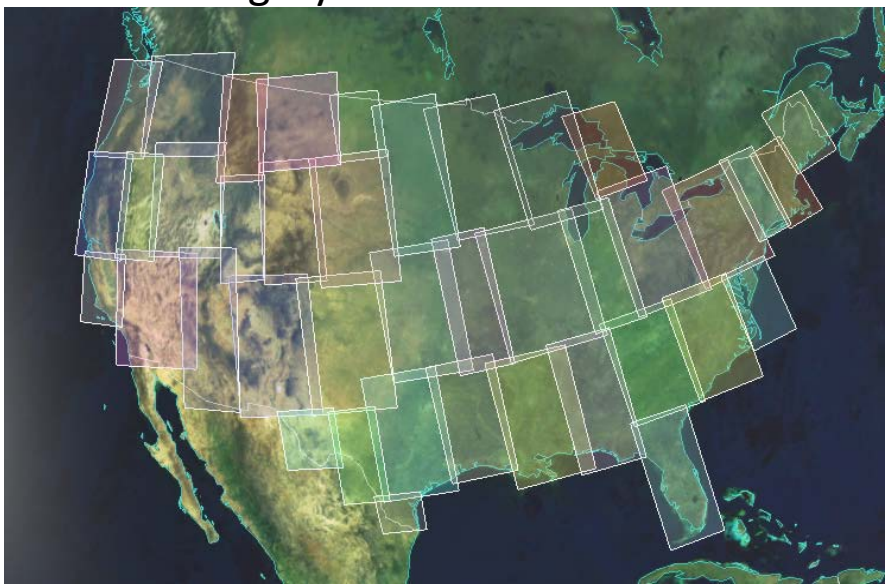
Image Courtesy Brad Rippey, 2013 USDA Ag Outlook Forum

2012 Cropland Data Layer Inputs

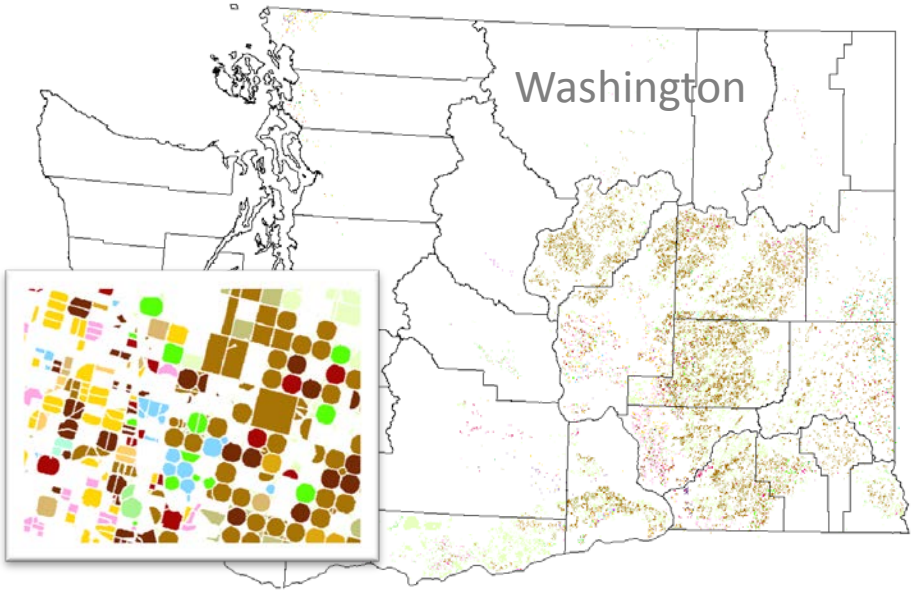
Satellite Imagery – Landsat (Fall 2011)



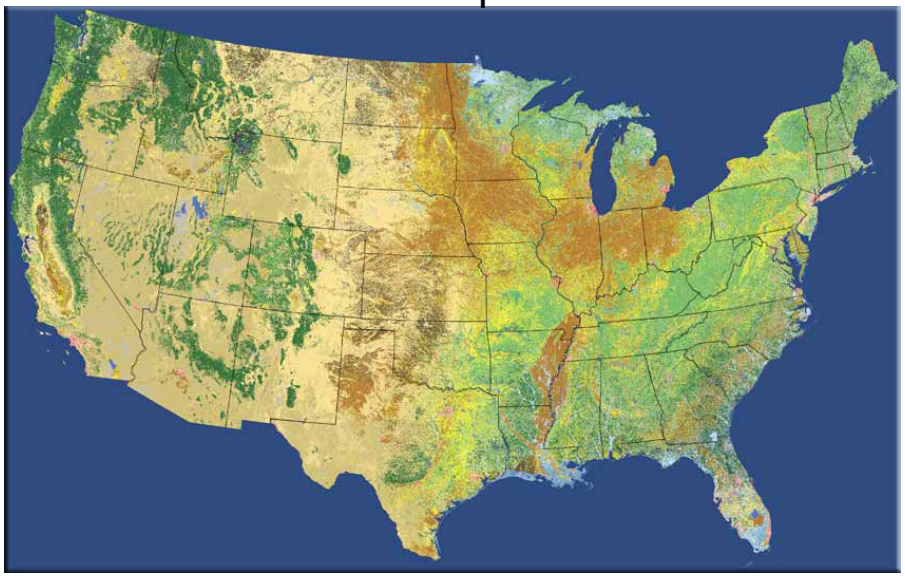
Satellite Imagery – Deimos-1 & UK2



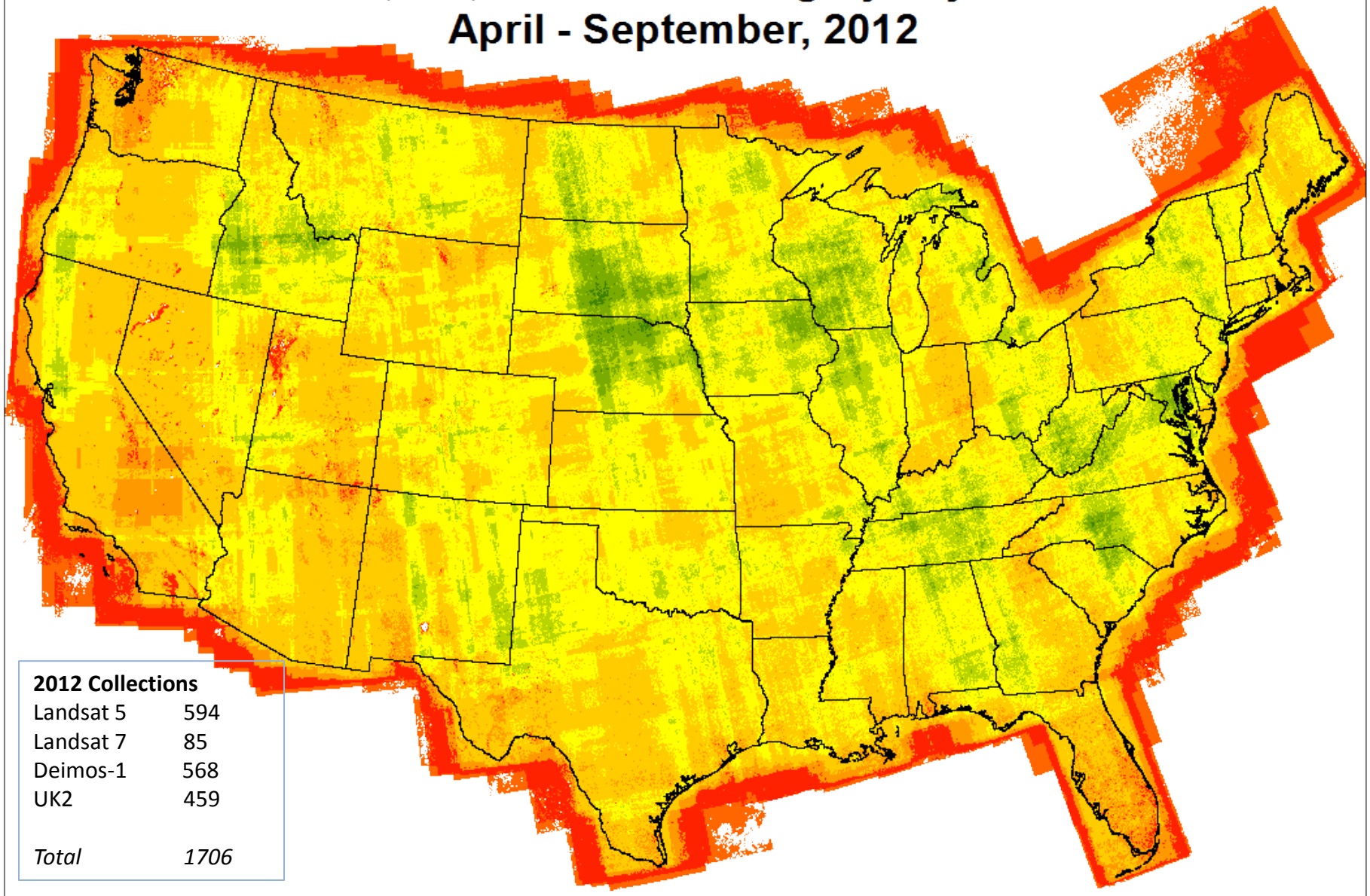
Farm Service Agency: Common Land Unit



2006 NLCD & Derivative products



Deimos, UK, Non-Cloud Imagery Layer count
April - September, 2012

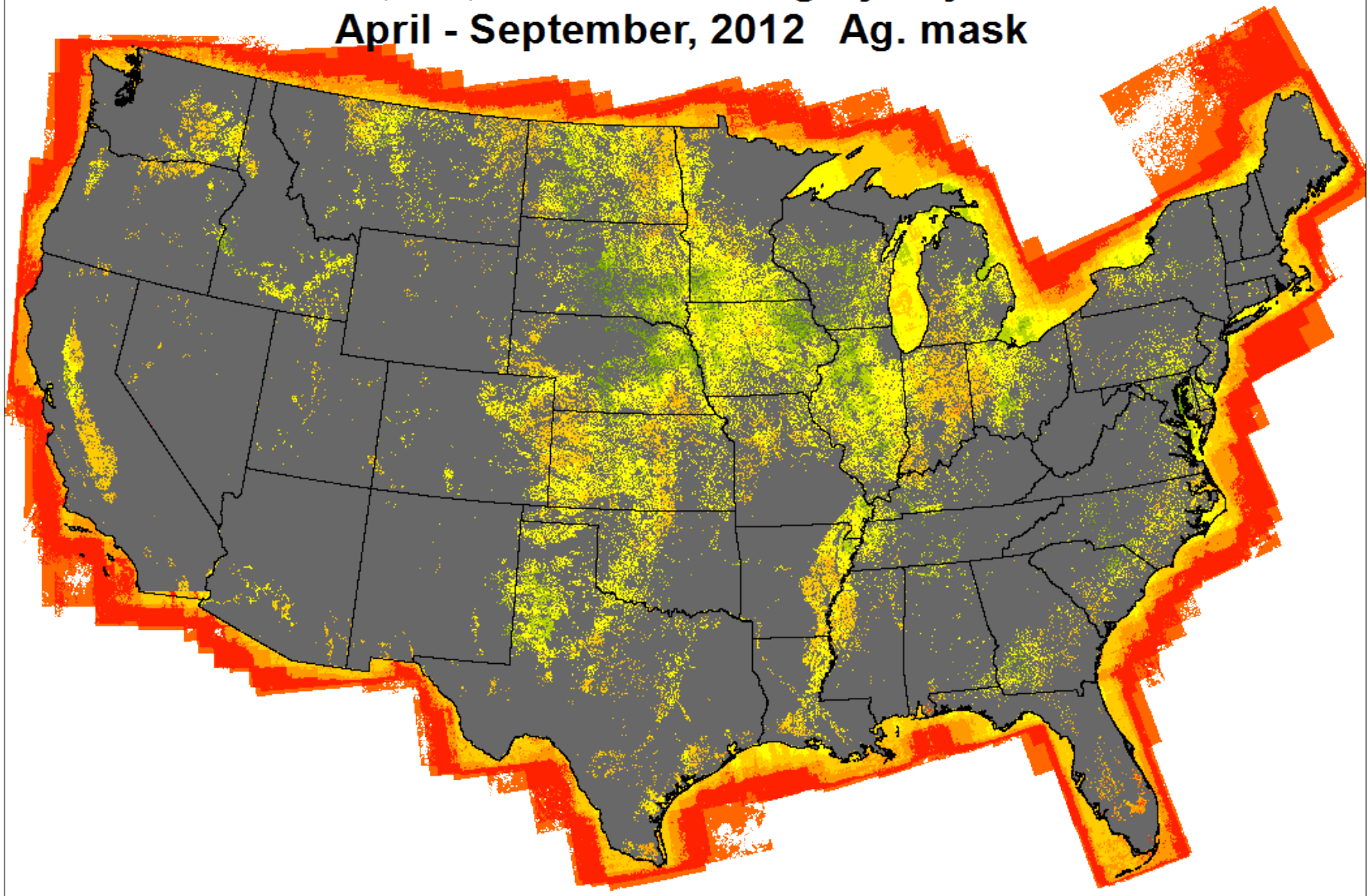


2012 Collections	
Landsat 5	594
Landsat 7	85
Deimos-1	568
UK2	459
Total	*1706*

NonCloud_Stack

- 1
- 1 < Count ≤ 7
- 7 < Count ≤ 11
- 11 < Count ≤ 15
- 15 < Count ≤ 18
- 18 < Count ≤ 22
- 22 < Count ≤ 26
- 26 < Count ≤ 29
- 29 < Count ≤ 30

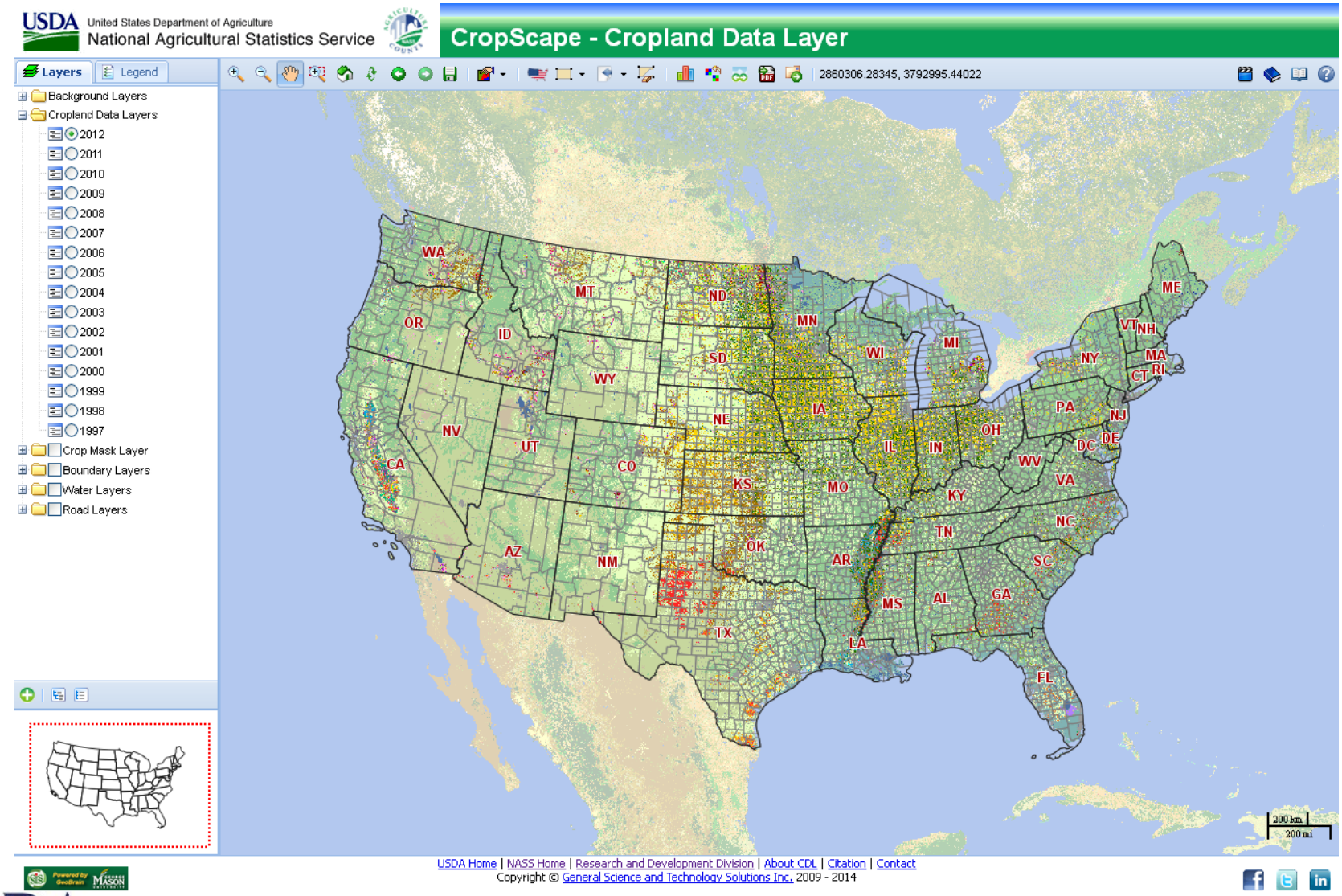
Deimos, UK, Non-Cloud Imagery Layer count
April - September, 2012 Ag. mask



NonCloud_Stack
1

1 < Count ≤ 7
7 < Count ≤ 11
11 < Count ≤ 15
15 < Count ≤ 18
18 < Count ≤ 22
22 < Count ≤ 26
26 < Count ≤ 29
29 < Count ≤ 30

CropScape: Interactive CDL Visualization/Exploration/Dissemination Portal

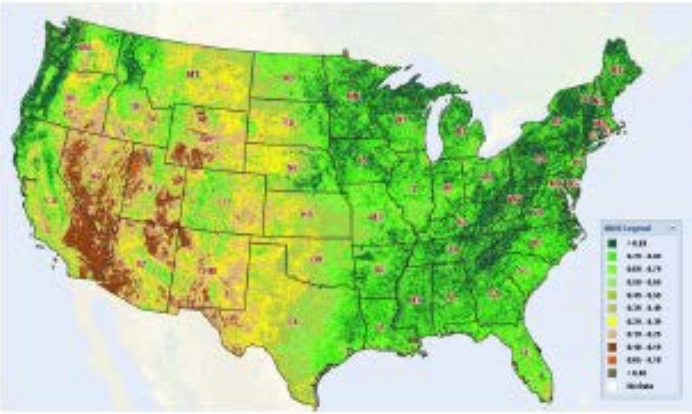


http://nassgeodata.gmu.edu/CropScape

VegScape

MODIS Derived **Weekly** Vegetation Condition

Normalized Difference Vegetation Index (NDVI)

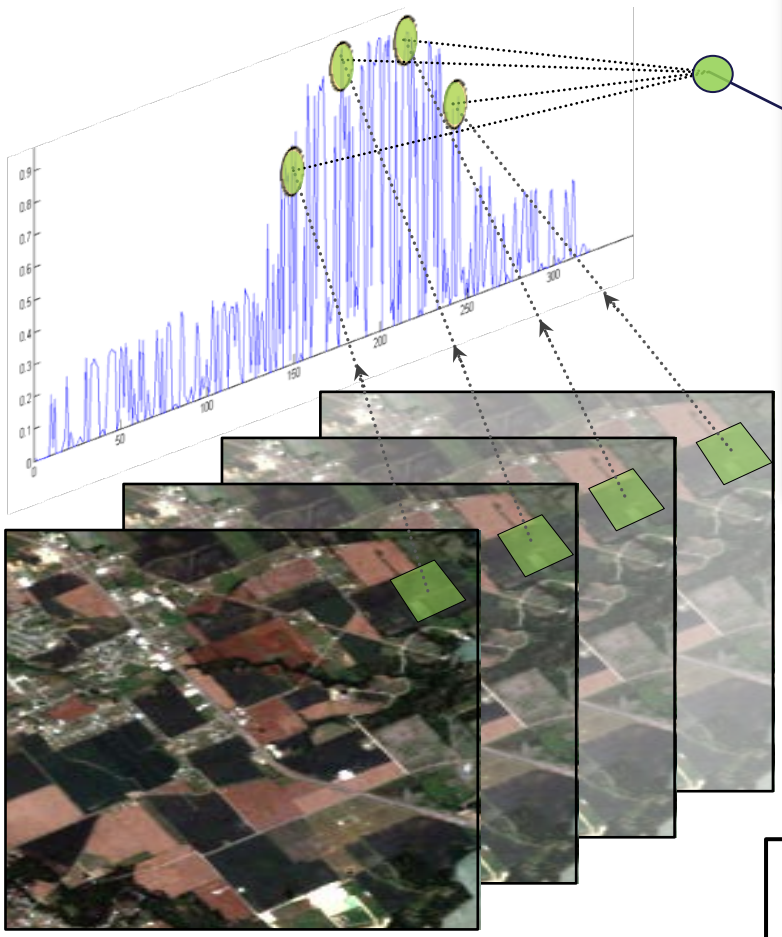


Ratio NDVI or RVCI

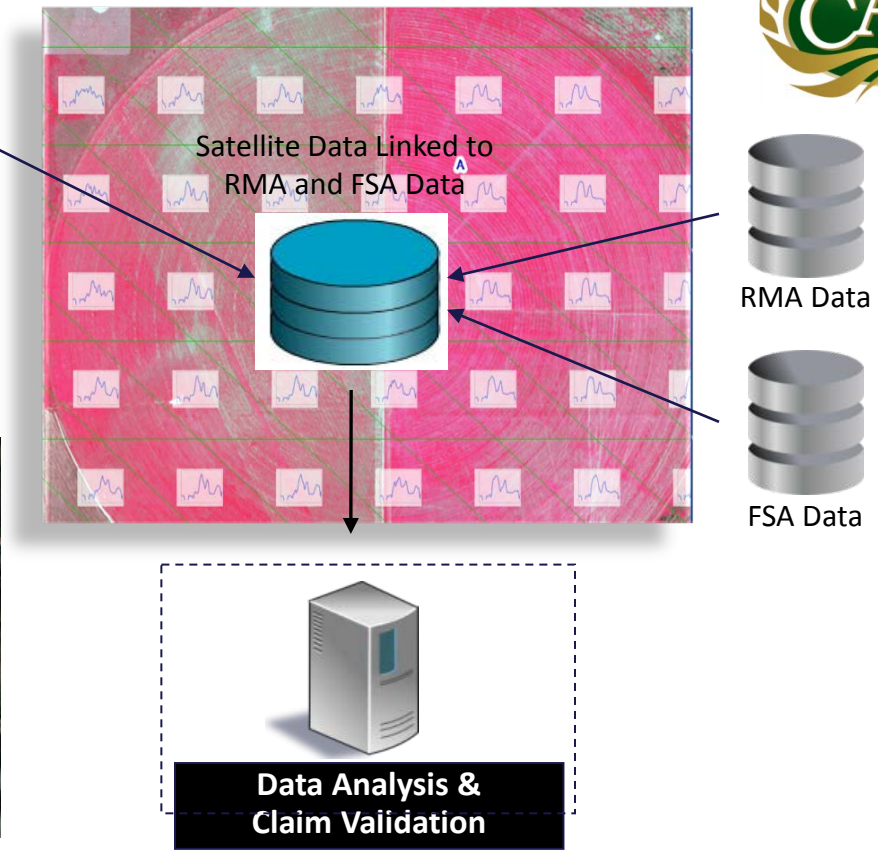
Ratio Median NDVI or RMVCI

Mean NDVI or MVCI

Spot Check Crop Insurance Claims Validation
PP Claims - Growth Curves



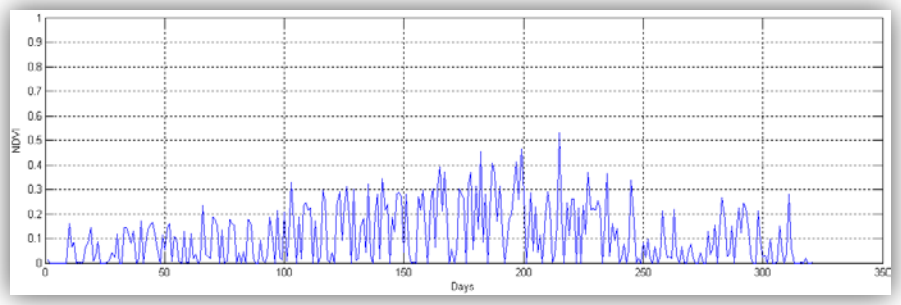
Daily MODIS Data Derives Growth Curves



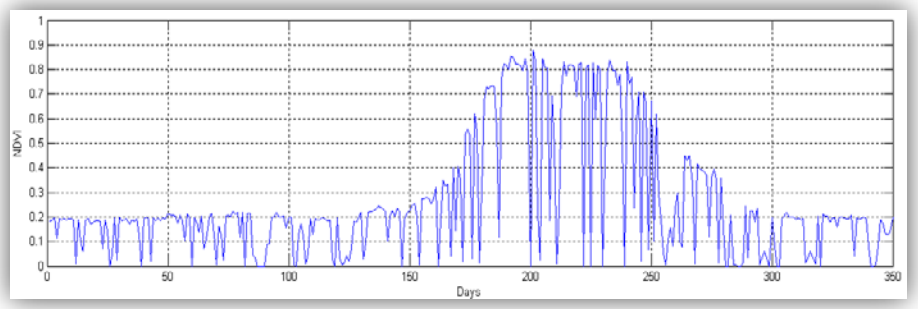
Growth Curves Linked to RMA and FSA Data are Used to Validate Producer Claim Reporting

Develop Crop Profiles at Pixel Level

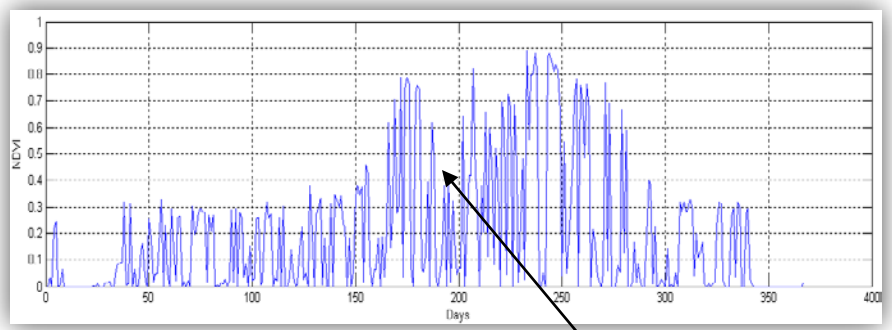
Crop Field Growth Curve Pattern



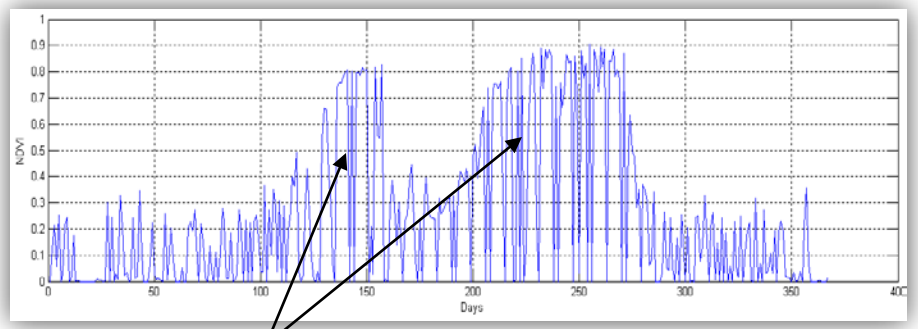
1. No Crop Growth Activity



2. Crop Growth



3. Insurance Claim (Event Indicated by Dip)



4. Consecutive Crops

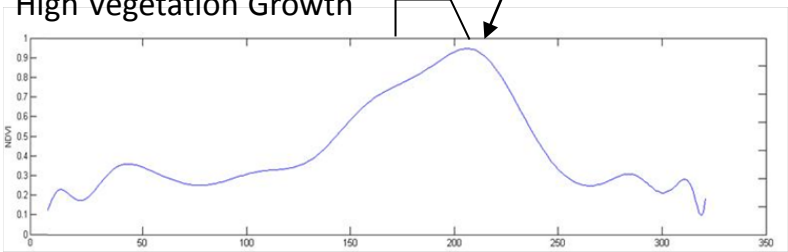
Spot Check Claims Validation

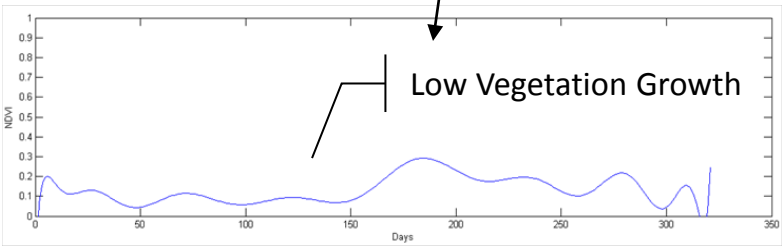
PP Claims - Growth Curves

Crop Growth Detected

No Crop Growth Detected

High Vegetation Growth





Low Vegetation Growth

USDA Forest Service Direct Readout Operations

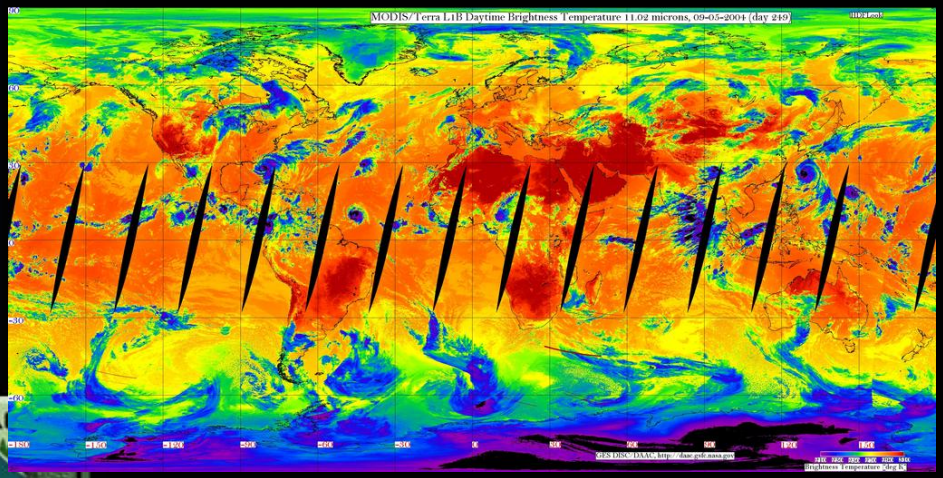
Support to the Fire Community:

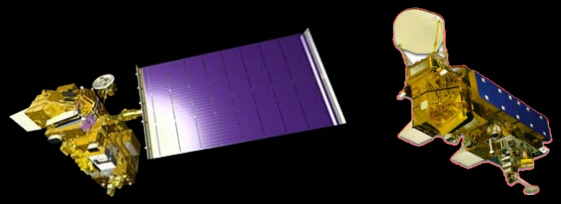
Near real-time imagery and fire-related data products from MODIS and VIIRS

RSAC = Remote Sensing Applications Center
Located In Salt Lake City, Utah

Slide Credit for this Section:
Brad Quayle
RDAS Program Leader
Everett Hinkley
National Remote Sensing Program Leader

MODIS

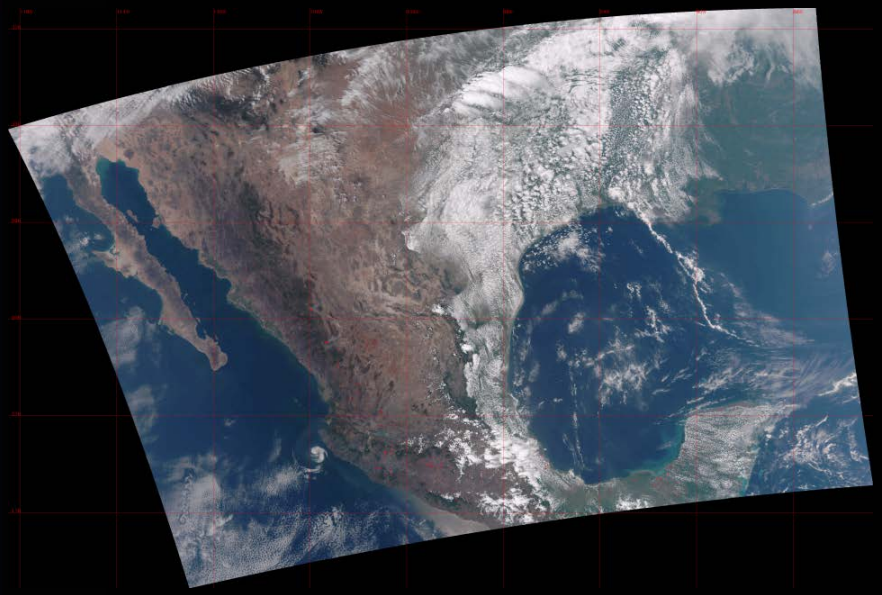




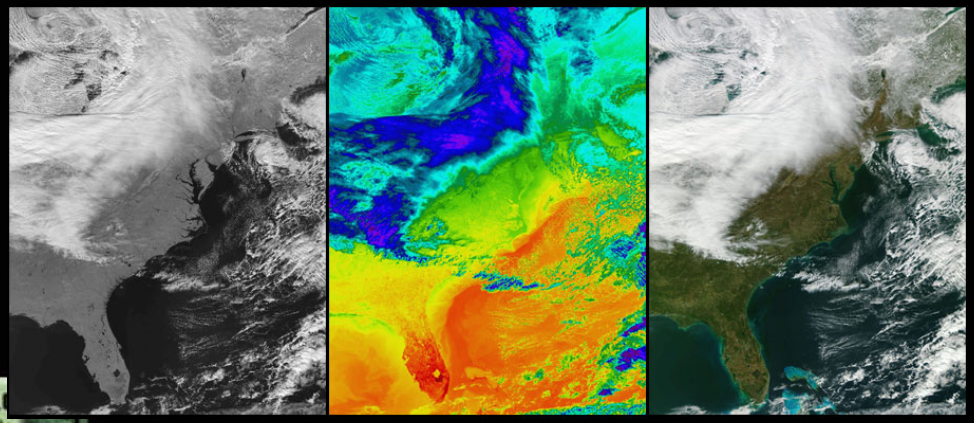
Terra Aqua

- Wide field of view
  - 2,330 km swath width
- Daily observations by each sensor of any point on the Earth's surface at latitudes > 30°
- Spatial resolution
  - 250m/500m/1,000m
- Surface reflectance imagery
  - 2 times daily (both sensors combined)
- Thermal/Emissive imagery
  - 4 times daily (both sensors combined)
- Terra and Aqua observations are offset ~2 ½ to 3 hours

VIIRS



April 13, 2012, (NOAA/University of Maryland)

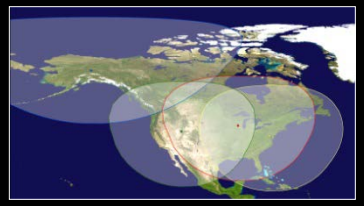


Suomi National Polar-orbiting Partnership

- Wide field of view
  - 3,000 km swath width
- Daily observations of nearly any point on the Earth's surface
- Surface reflectance imagery
  - Once daily
- Thermal/Emissive imagery
  - 2 times daily
- NPP VIIRS and Aqua MODIS observations are nearly coincident
- Spatial resolution
  - 375m/750m

RSAC Direct Readout Data Processing

DR Ground Station Network



Selected
MODIS/VIIRS L0/L2 Data
(every 15-20 minutes)

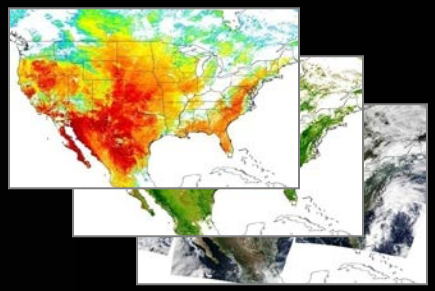
MODIS Rapid Response System

L2 data via LANCE
(every 15 minutes)

LAADS Web

Level 1 and Atmosphere Archive and Distribution System

Selected L0
Data



L2 Product Stream
for U.S. and
Canada

L2 Products

L2 Products
(~40 GB daily)

RSAC

L0 Data
(12-14 GB daily)

USFS-RSAC IPOPP
Processing System

NASA International Polar Orbiter Processing Package (IPOPP) used for processing

IPOPP MODIS/VIIRS L2/L3 Products

- Active Fires
- Land Surface Temperature
- Corrected Reflectance
- Surface Reflectance
- Day/Night Band
- NDVI/EVI
- Snow Cover
- Burn Scar
- Aerosol Products
- Cloud Products
- Sea Surface Temperature
- Chlorophyll A
- Etc., etc.

Active Fire Mapping (AFM) Program

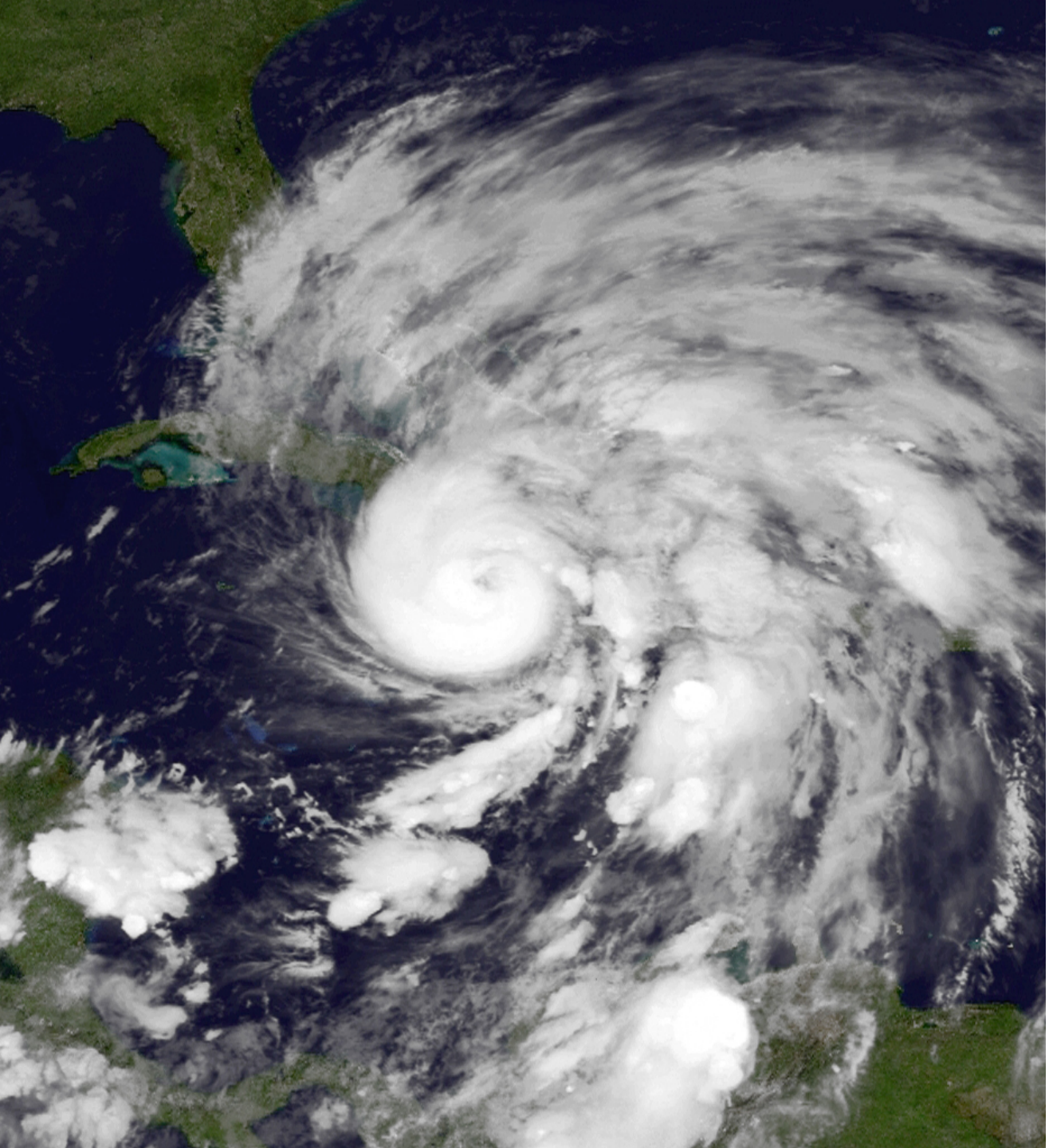
(http://activefiremaps.fs.fed.us)

- Satellite detection and monitoring of wildfire activity in CONUS, Alaska, Hawaii & Canada

★ Leverages NASA and NOAA assets
  - MODIS
  - GOES
  - AVHRR
  - VIIRS

- Facilitates decision support for strategic planning & response for U.S. and Canadian fire agencies
  - Prioritize allocation of fire suppression assets
  - Integrated into fire-related applications and decision support systems

★ Developing new capabilities
  - Early detection
  - Spatially refined data

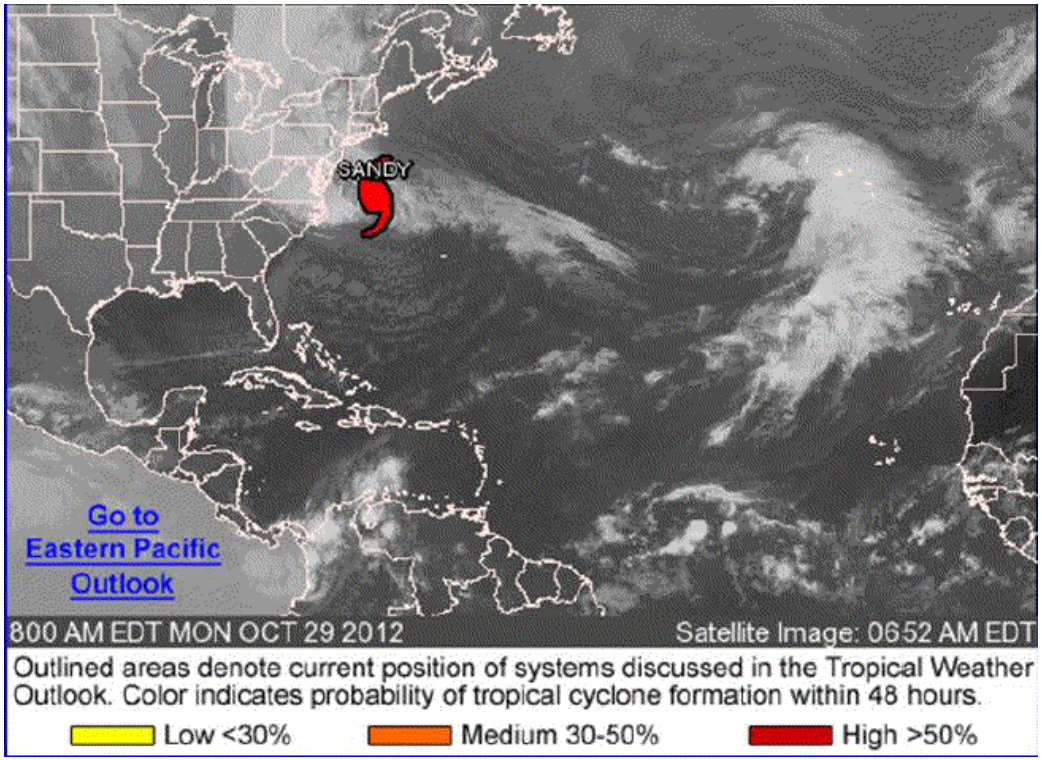


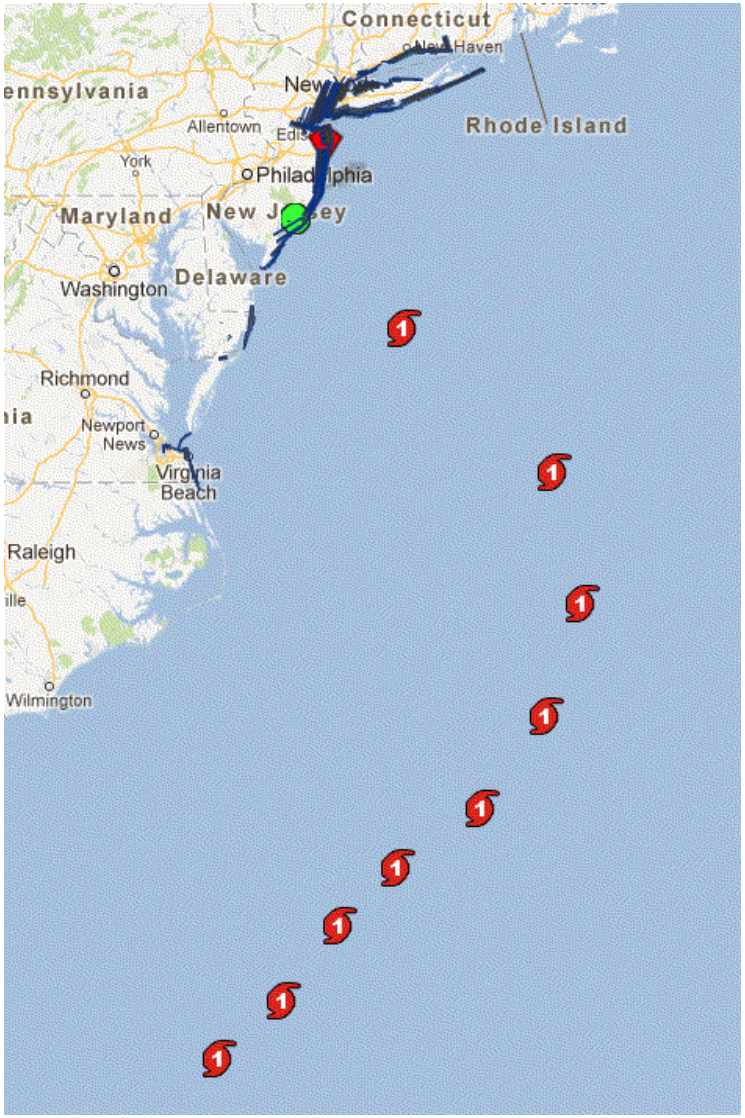
Hurricane Sandy

Imagery

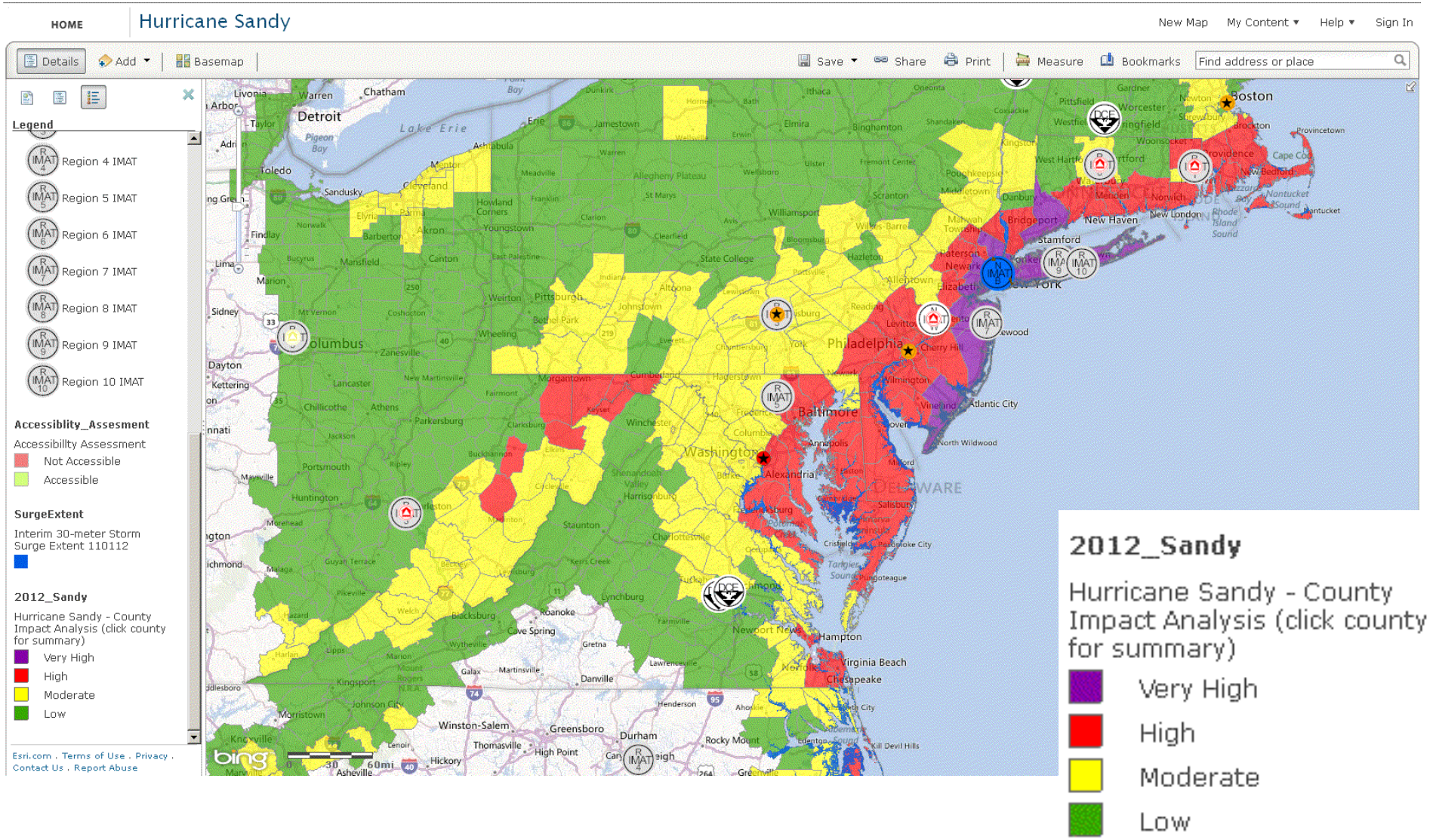
NOAA GOES
October 25, 2012

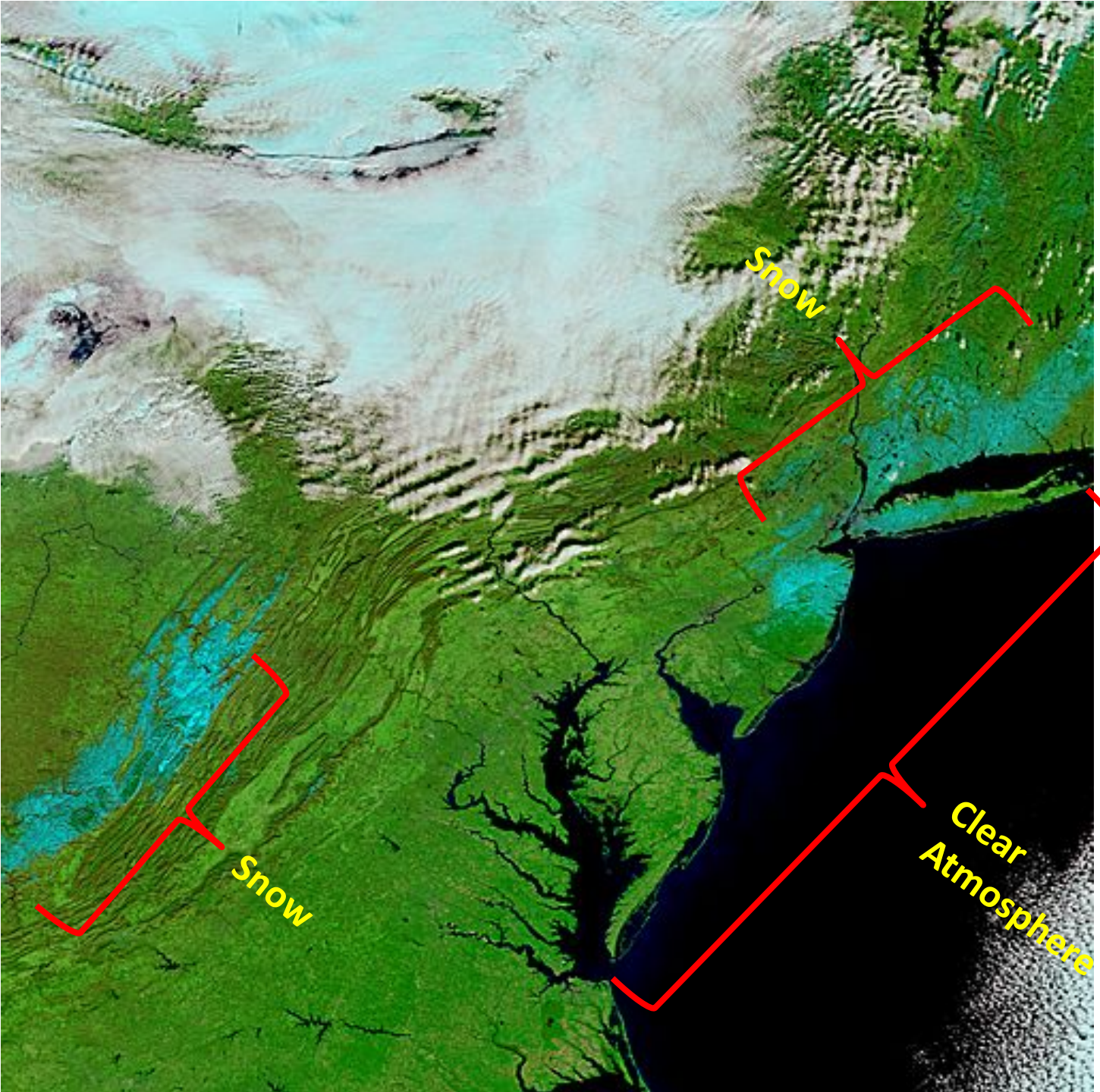
Hurricane Sandy:
Large and Slow Moving





Impacted Area





US Sandy Landfall:
October 30, 2012

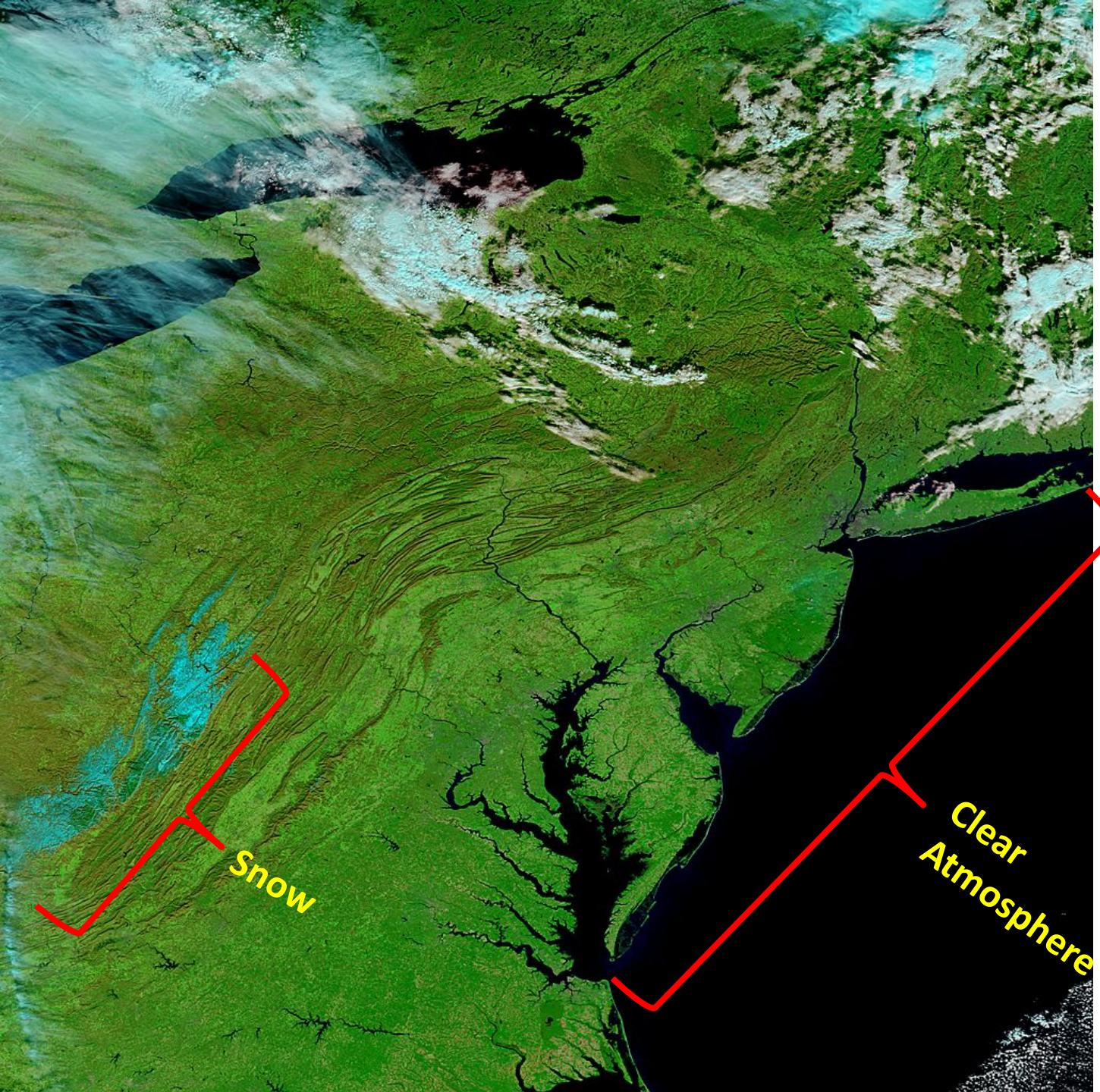
November 9, 2012
MODIS Terra 721

11/9 was first mostly clear day.

Allows view from Space

10 days after Landfall

http://www.pecad.fas.usda.gov/cropexplorer/modis_summary/



US Sandy Landfall:
October 30, 2012

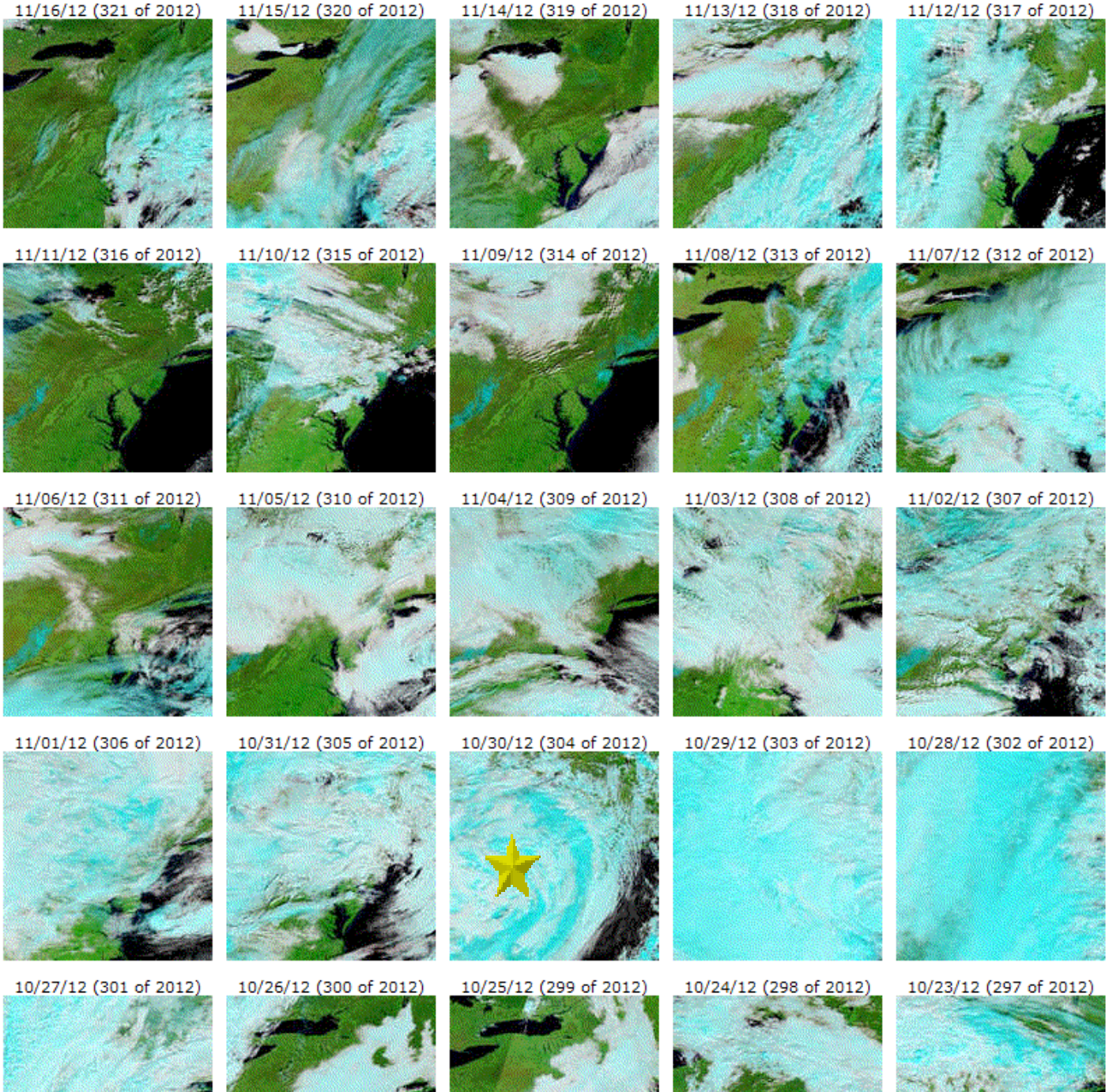
November 11, 2012
MODIS Terra 721

11/12 was second mostly clear day.

Allows view from Space

12 days after Landfall

Select Satellite **Satellite: terra.721 Region: r14c11 Year: 2012**



Clouds Present Majors Issues With Disaster Acquisitions

http://www.pecad.fas.usda.gov/cropexplorer/modis_summary/

Imagery Acquired Post-Landfall for Damage Assessments

Public Domain

- **NOAA Aerial Imagery**
  - 3,731 Images
- **Civil Air Patrol**
  - **158,012** Oblique Images
- **NC DOT Aerial Imagery**
  - 194 Images
- **EO 1 + Hyperion**
  - 18 Images
- **International Space Station**
  - 78 Images
- **Landsat 7**
  - 4 images
- **EPA Aspect Aerial Imagery**

Licensed

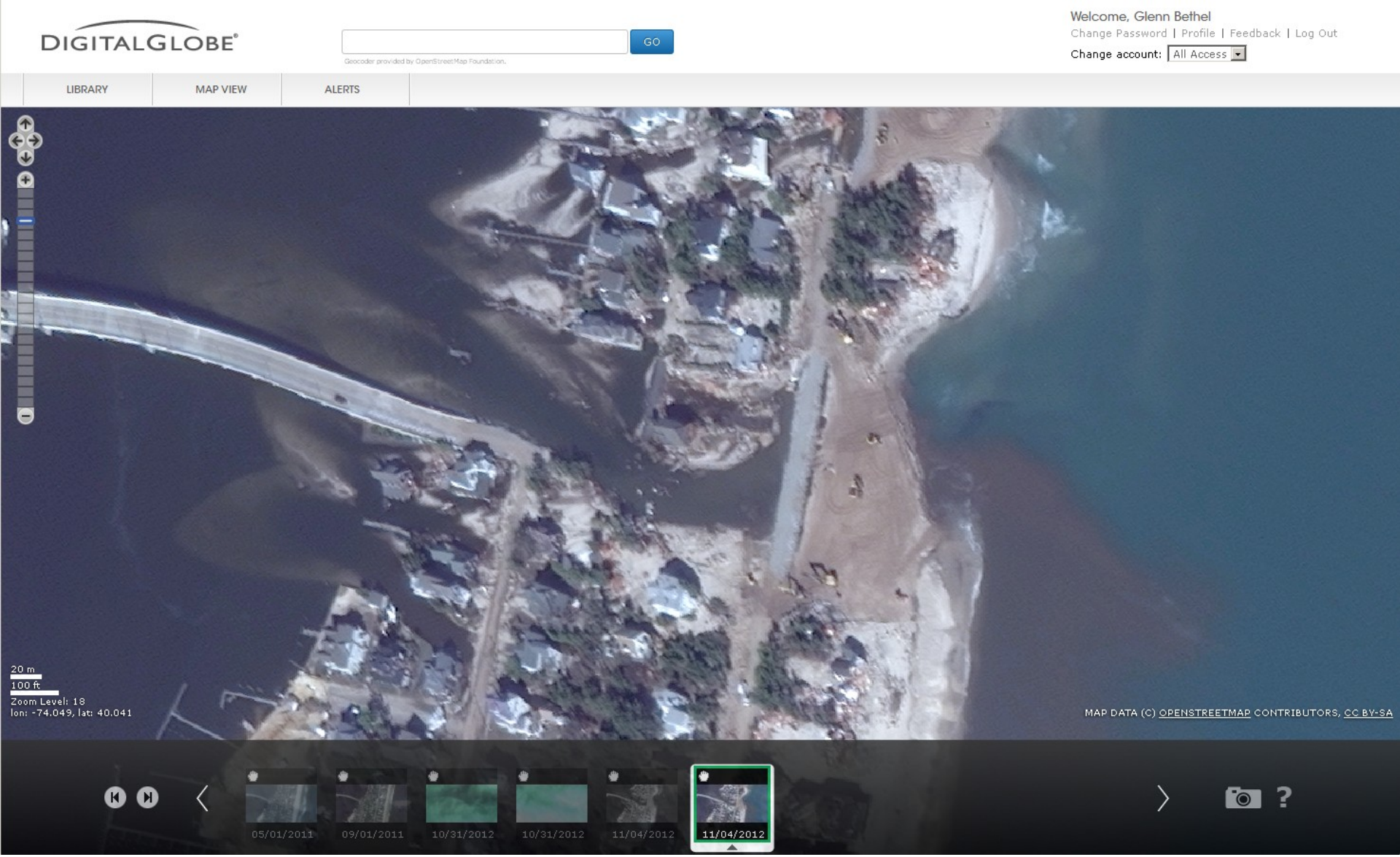
- **WorldView 1 & 2**
  - 1,028 images
- **SPOT**
  - 66 images
- **Radarsat-2**
  - 18 images
- **COSMO**
  - 8 images
- **TerraSar-X**
  - 4 images

SAR

- **DMC**
  - 3 images
- **RapidEye**
  - 3 images
- **QuickBird**
  - 2 images

October 31, 2012 Flight 2
Mantoloking, NJ

November 1, 2012 Flight 1
Mantoloking, NJ



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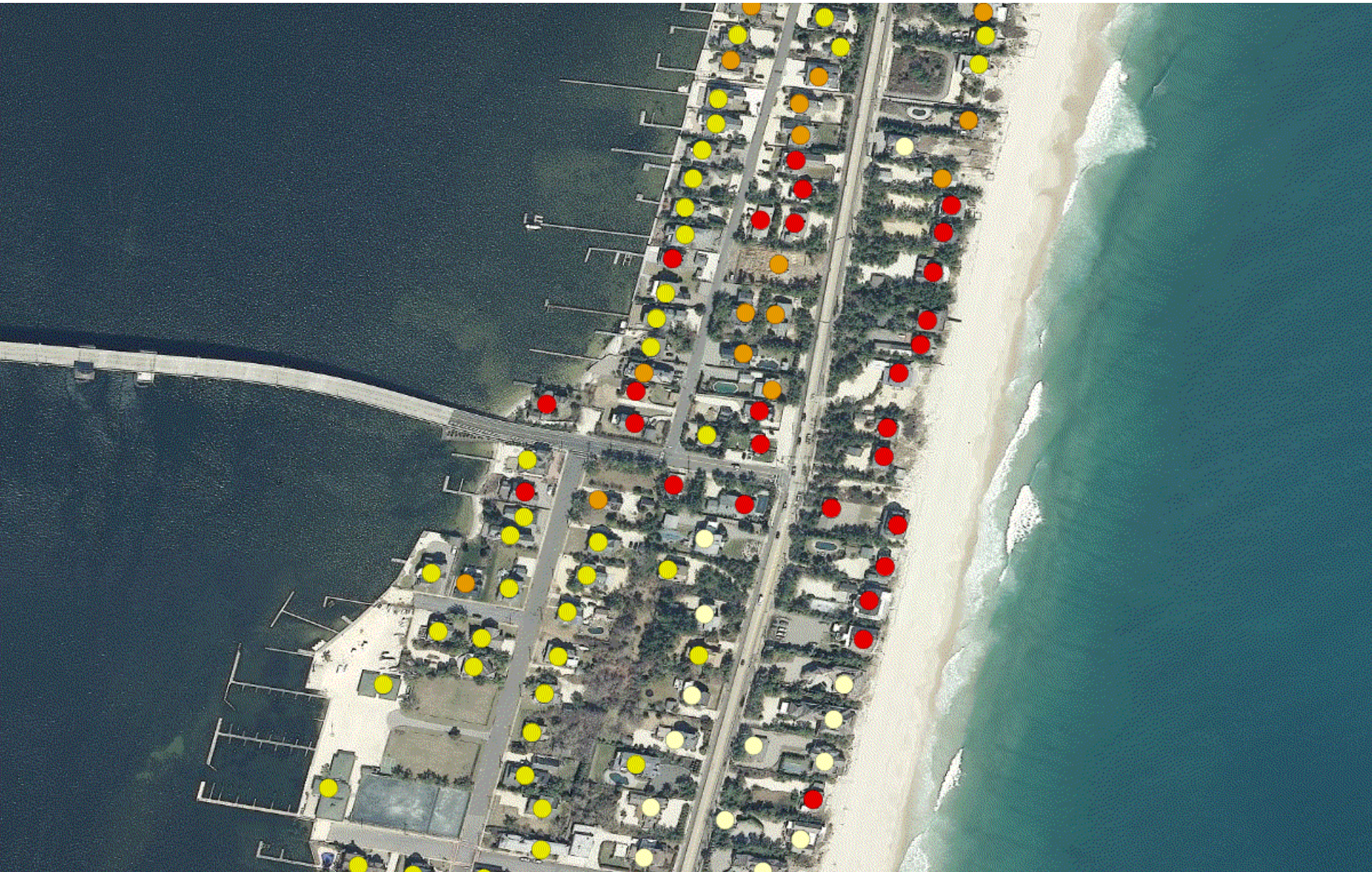
Mantoloking, NJ

November 4, 2012

FEMA Contractors used Imagery to make Initial Damage Assessments

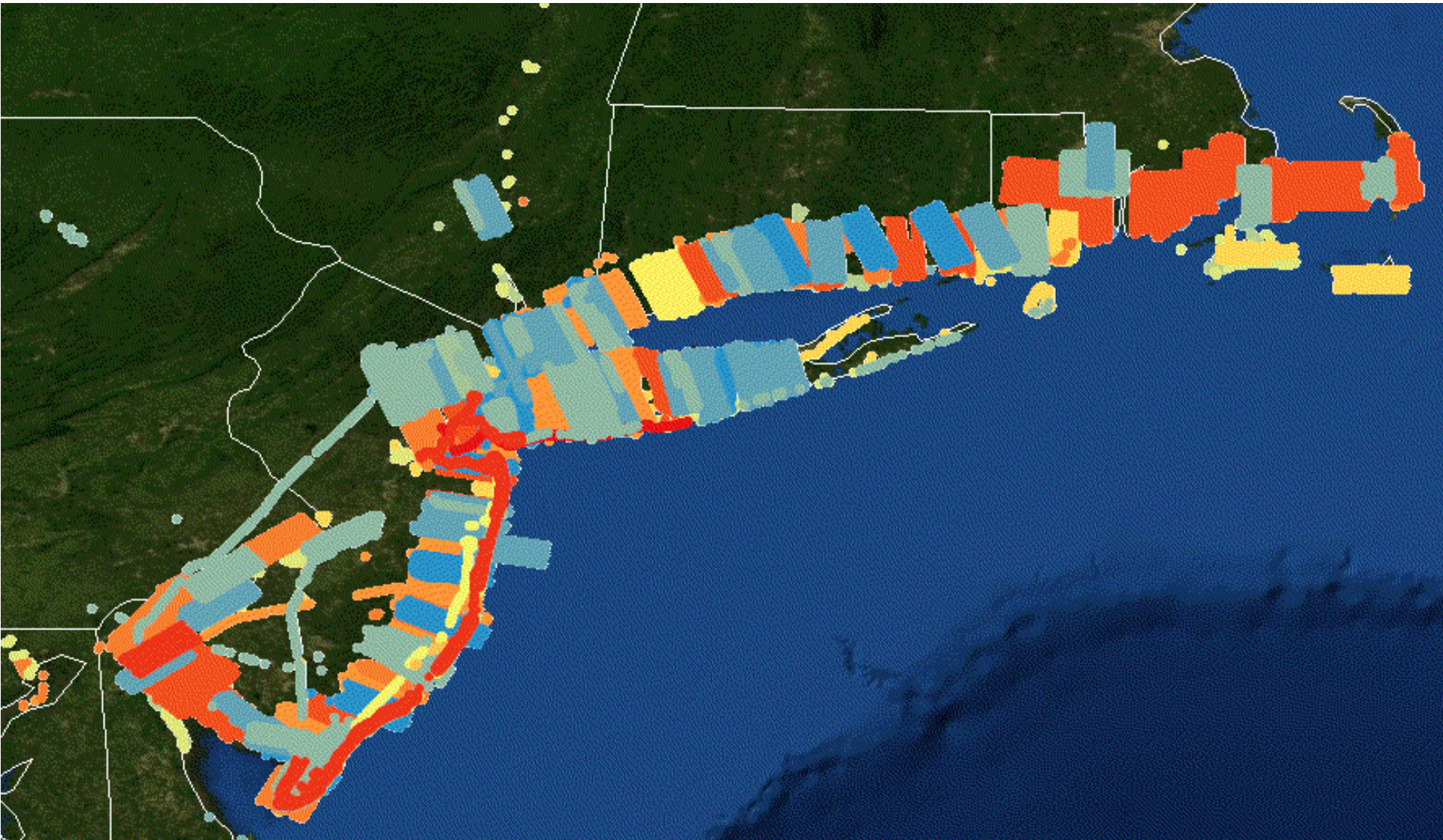


CAP November 11, 2012

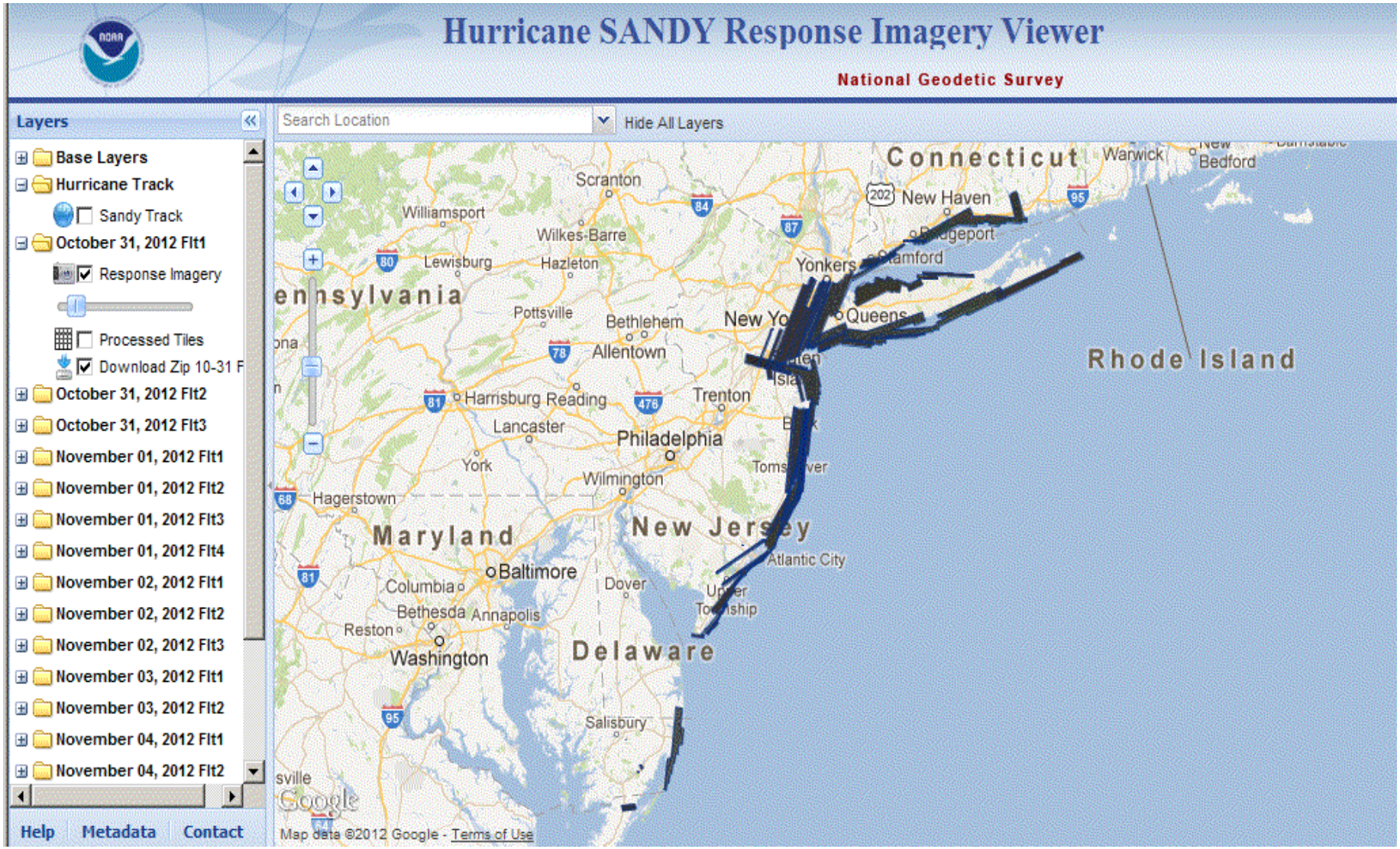
CAP November 18, 2012

Civil Air Patrol

158,012 Oblique Images
Acquired Over 20 Days



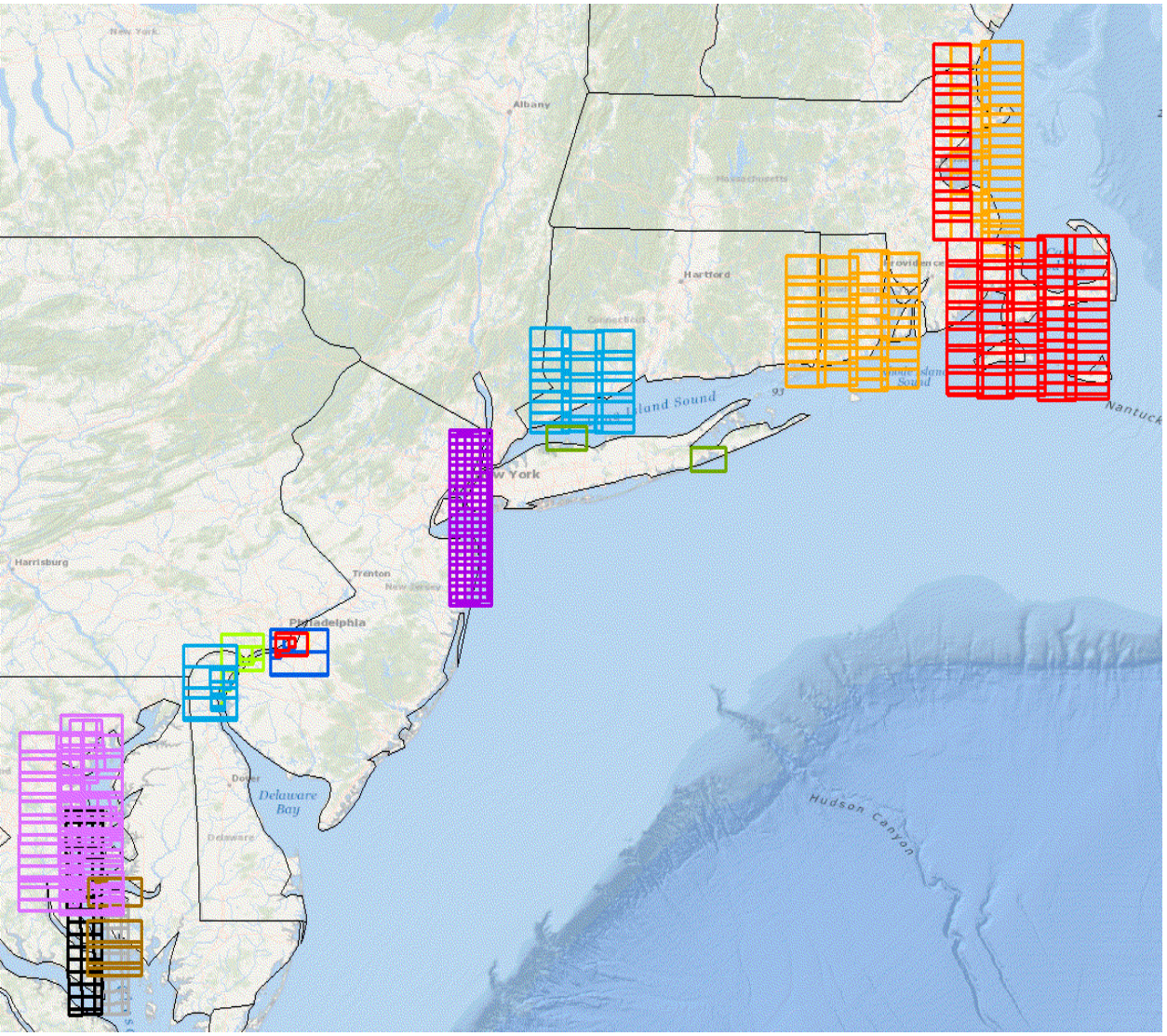
NOAA Aircraft Flying Below The Clouds Starting Oct 31.



3,731 Images Acquired Over 6 Days

http://ngs.woc.noaa.gov/storms/sandy/

WorldView Imagery Acquired by NGA and Loaded to HDDS



- 2012-11-22
- 2012-11-20
- 2012-11-19
- 2012-11-17
- 2012-11-12
- 2012-11-09
- 2012-11-08
- 2012-11-06
- 2012-11-03
- 2012-11-02

Animation: NJ 2012 Pre-Event, NOAA Oct 31 and Nov 1, 2012

Questions?

Civil Air Patrol:
Casino Pier and Breakwater Beach Waterpark , Seasideheights, NJ