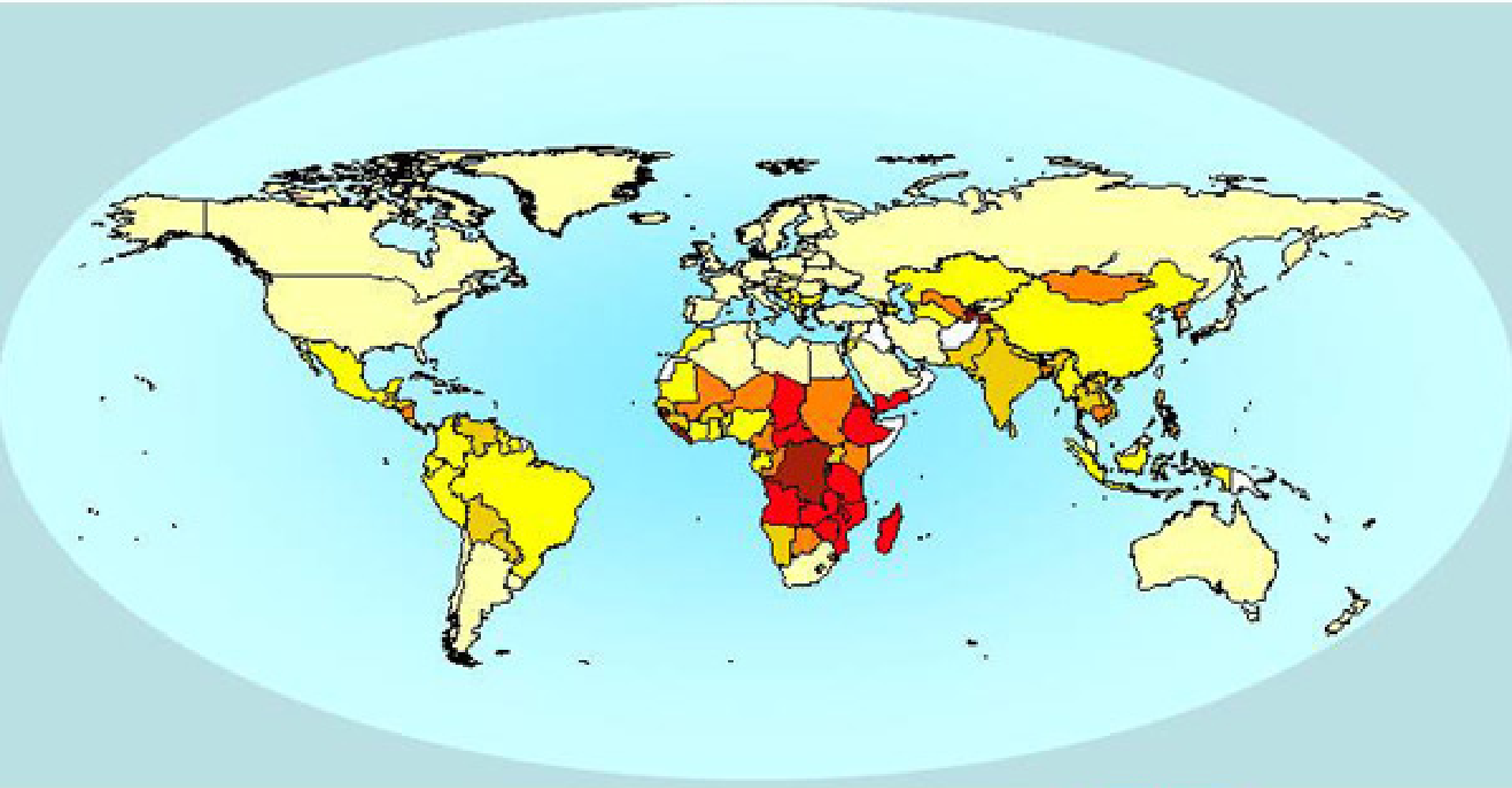
Expanding the Use of Land Imaging for Agriculture Decision Making:

The Global Agriculture Monitoring (GLAM) Partnership

Hunger map



%	< 5	5 - 15	15 - 25	25 - 35	35 - 50	> 50	No data

النسبة المئوية للنقص التغذية

营养不足人口

Undernourished population

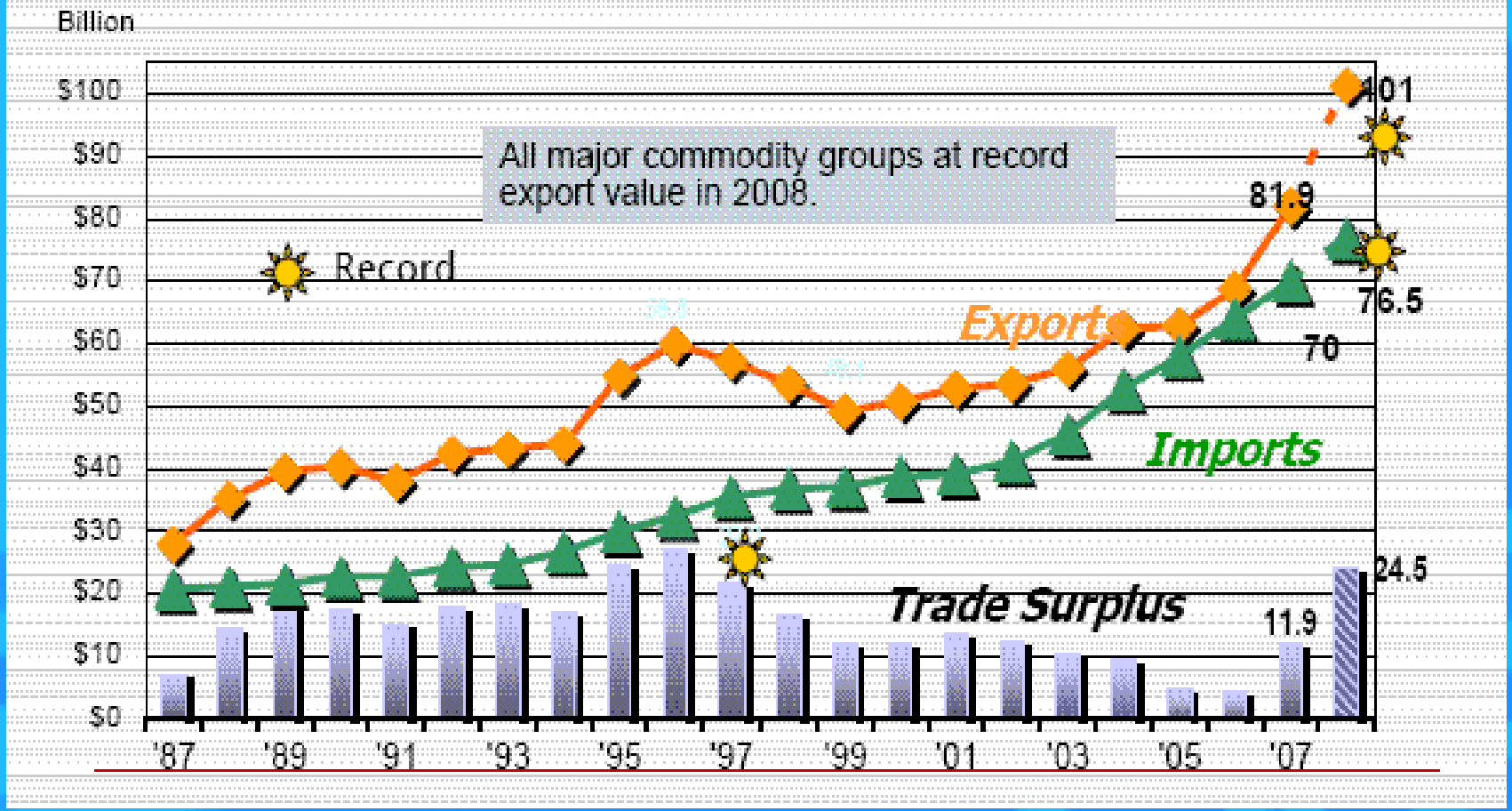
Population sous-alimentée

Población subnutrida

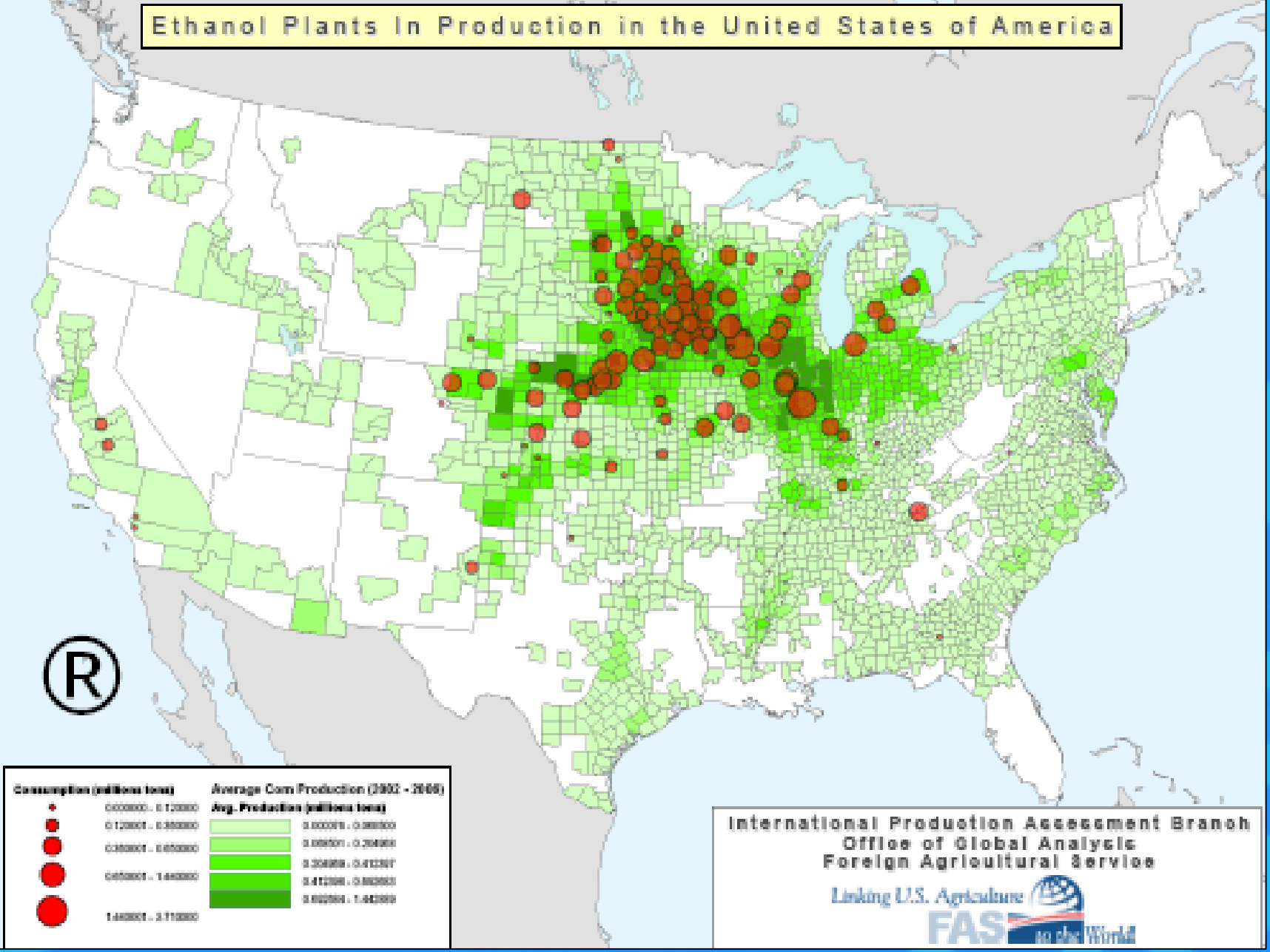
2002-2004

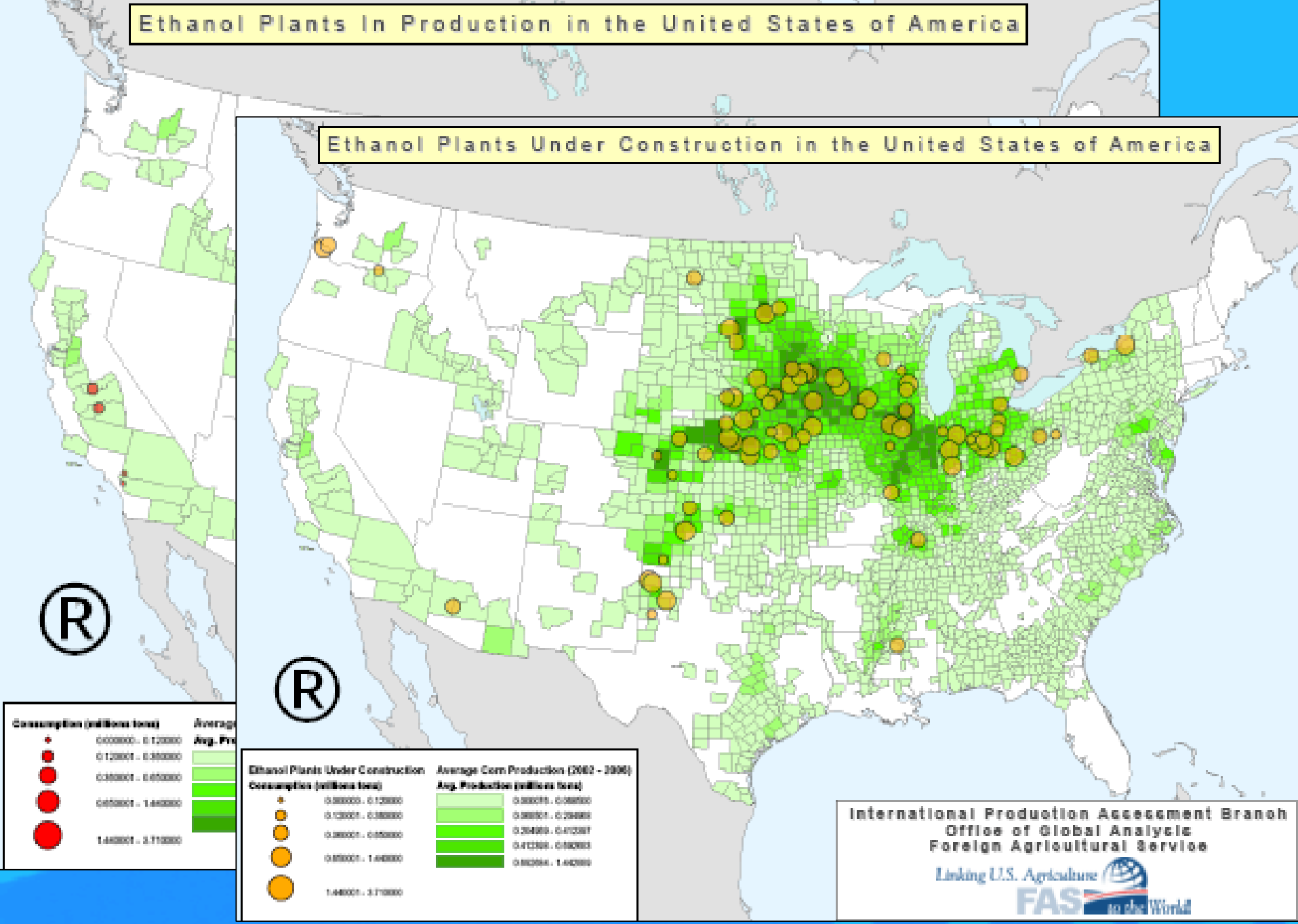
FAOSTAT

U.S. Agricultural Exports and Imports



From World Agriculture Outlook Board Situation and Outlook for Agriculture Commodities, http://www.usda.gov/oce/speeches/index.htm


Ethanol Plants In Production in the United States of America
Consumption (millions tons)
Average Corn Production (2002 - 2006)
Avg. Production (millions tons)
International Production Assessment Branch
Office of Global Analysis
Foreign Agricultural Service
Linking U.S. Agriculture to the World
FAS

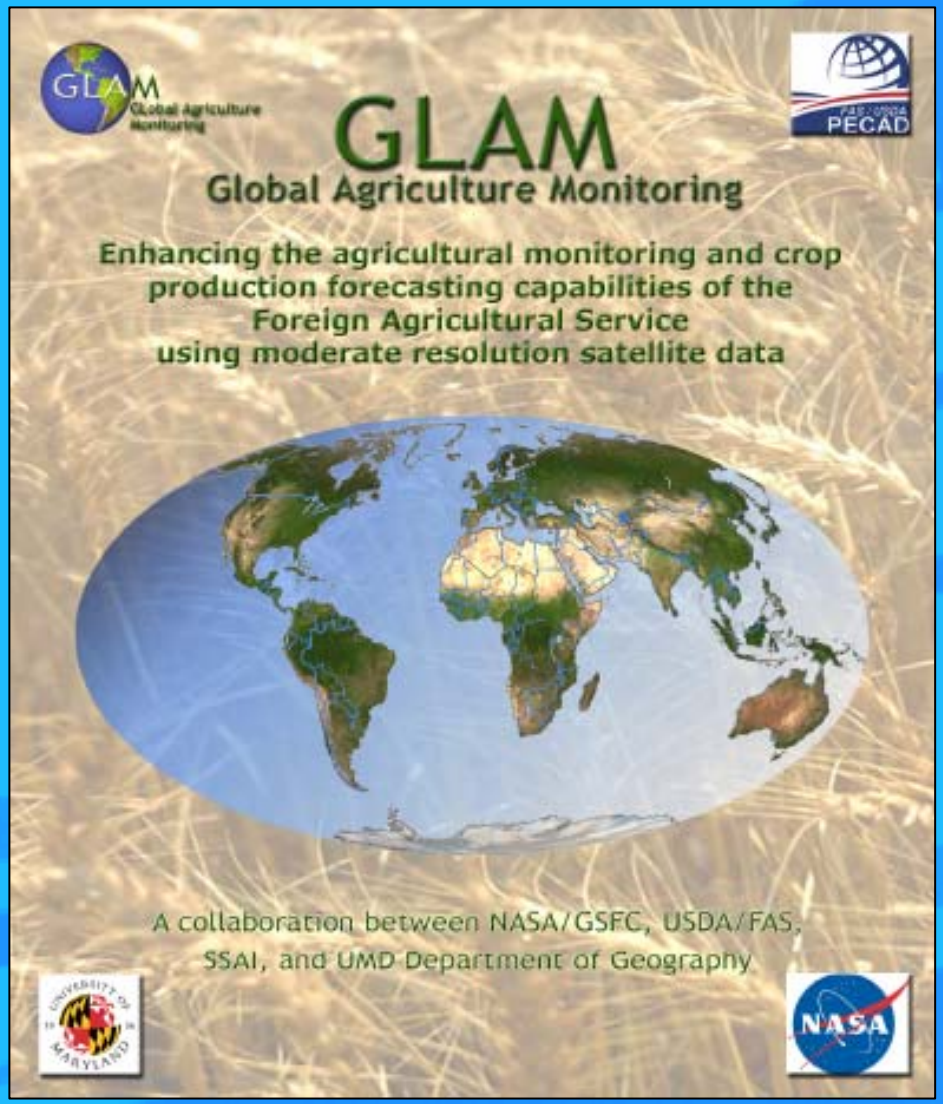

Ethanol Plants In Production in the United States of America
Ethanol Plants Under Construction in the United States of America
Ethanol Plants Under Construction
Consumption (millions tons)
Average Corn Production (2002 - 2006)
Avg. Production (millions tons)
International Production Assessment Branch
Office of Global Analysis
Foreign Agricultural Service
Linking U.S. Agriculture to the World
FAS

3 JUNE 74

25 JUNE 75

LACIE & AgriStars pioneer multi-agency collaboration for monitoring agriculture with satellites

NRC, http://www.nap.edu/ssb/rapch2.htm



GLAM is the NASA-USDA led partnership to leverage NASA technology to improve the FAS global agriculture monitoring and reporting mission.

From FAS Mission Statement and Appropriations:

…maintain a world-wide agriculture reporting system

…analyze production and trade

….using remote sensing and other technologies

Toolbox

FAS_Brazil3

04/17/07 (Day 107 of 2007)

Previous Day

Last 30 Days All Images

7-2-1 Composite (SWIR/NIR/RED)

Terra (AM)

Pixel size:
250m | 500m | 1km

Aqua (PM)

Pixel size:
250m | 500m | 1km

True Color

Terra (AM)

Pixel size:
250m | 500m | 1km

MODIS Image Gallery
FAS_Brazil3

(MODIS Image Archive is available from 01/01/2004)

Select a date to view the past MODIS data

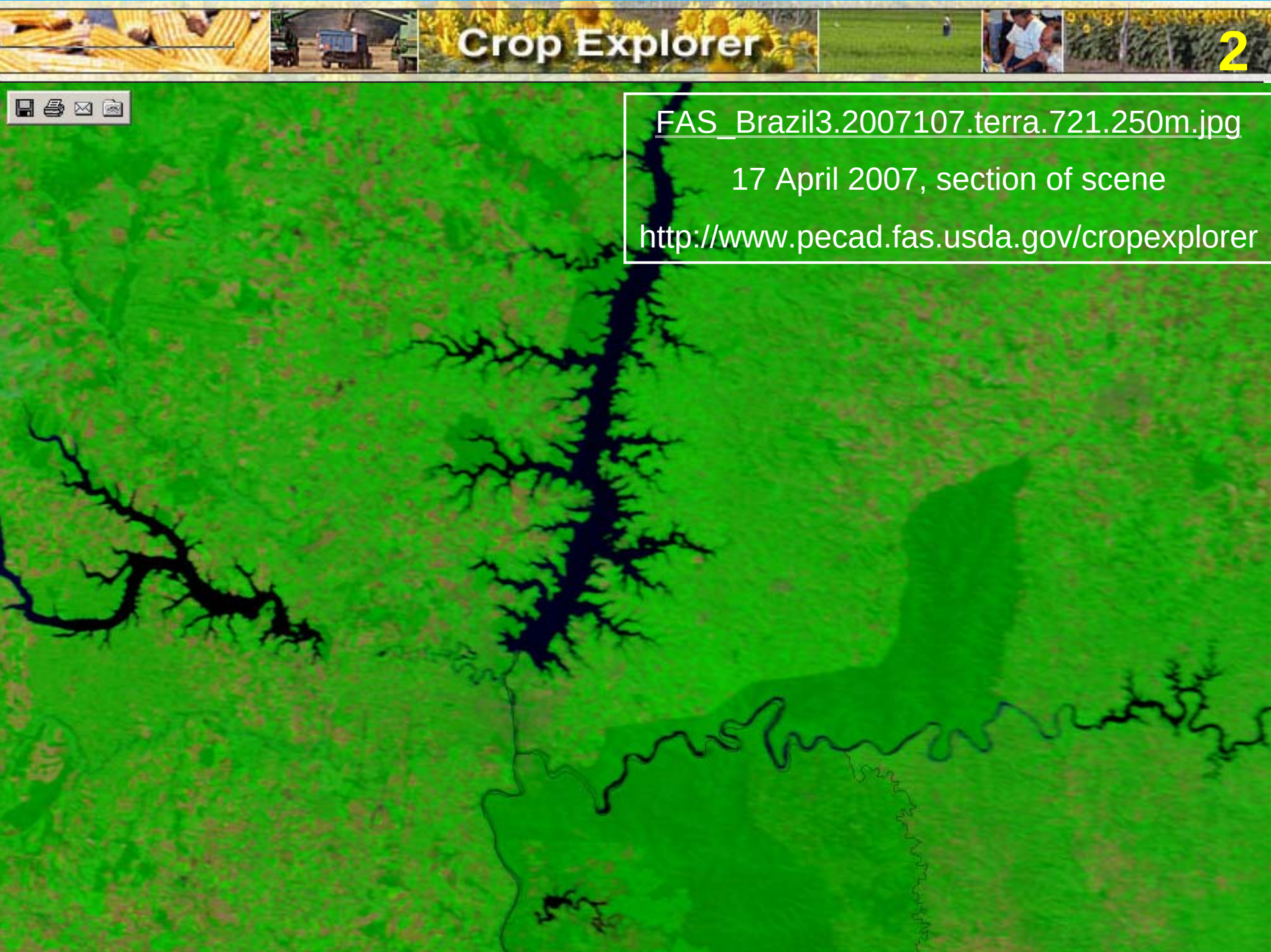
Month | Day | Year | Go

Select a new region to view the MODIS data

Download Images

Regional View allows user to choose:

1. **Band Combination for MODIS Imagery**
2. **Specific date**
3. **Specific Resolution**
4. **Download data to your GIS**



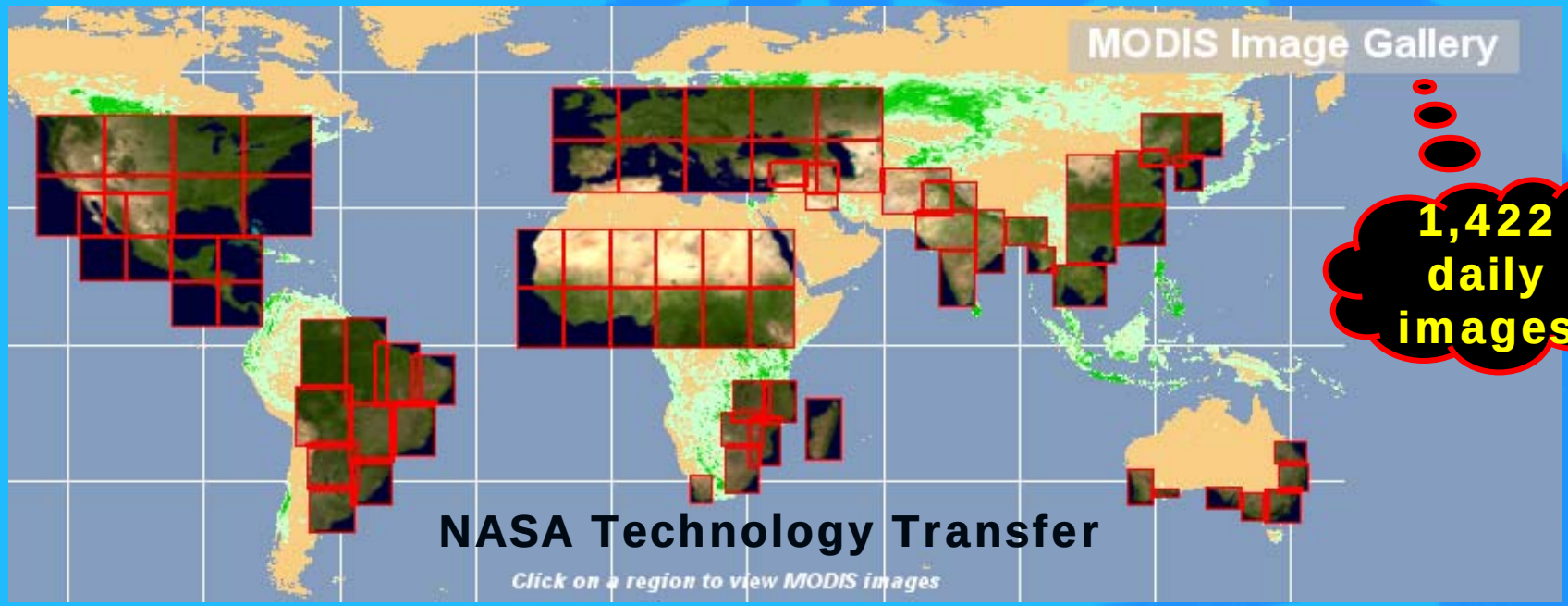
FAS_Brazil3.2007107.terra.721.250m.jpg

17 April 2007, section of scene

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

MODIS Rapid Response Image Gallery

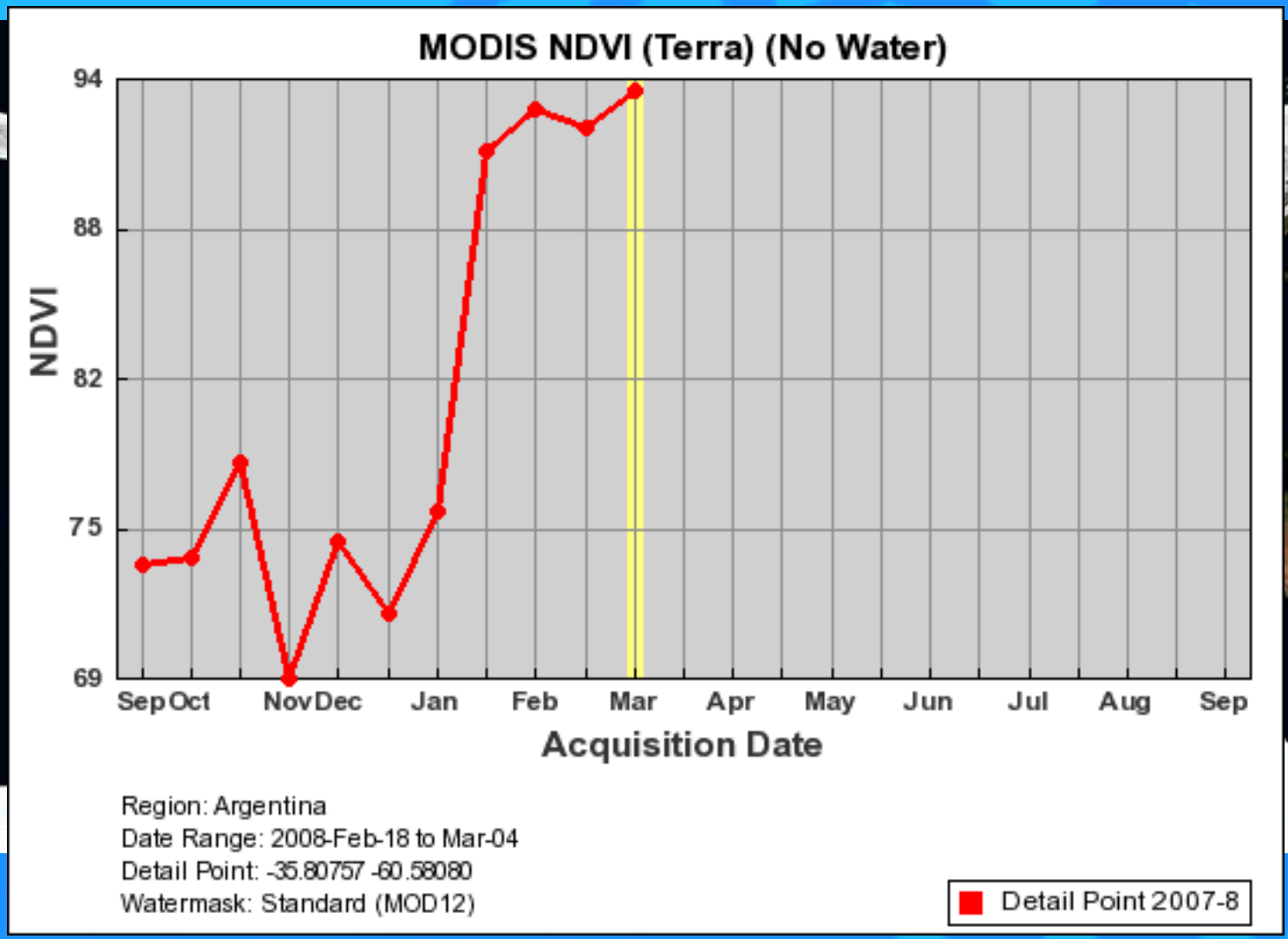
http://www.pecad.fas.usda.gov/cropexplorer/



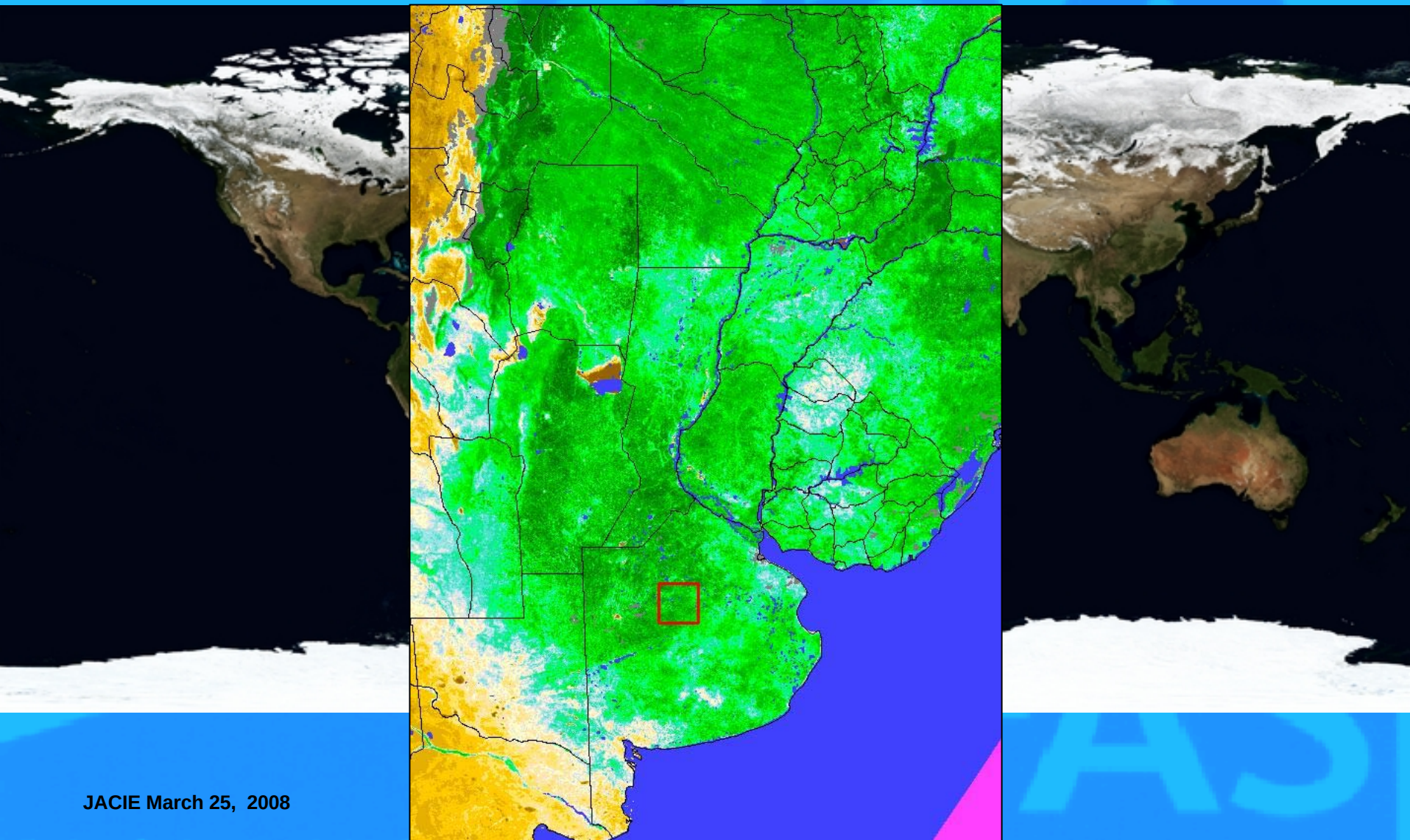
MODIS provides rapid views of agricultural regions.

- Two satellites (aqua & terra); three resolutions (250m, 500m, & 1,000m); two formats (jpg & geoTiff); three band combinations (true color; 7,2,1; and NDVI).
- Images are available ~ ***six hours*** after acquisition.

Global Vegetation Conditions in Time-Series

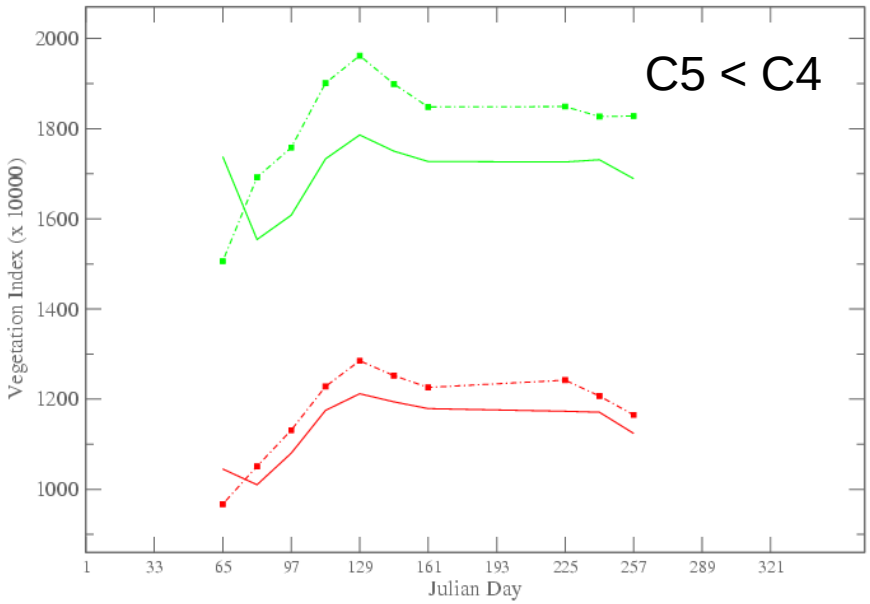


Global Vegetation Conditions in Time-Series



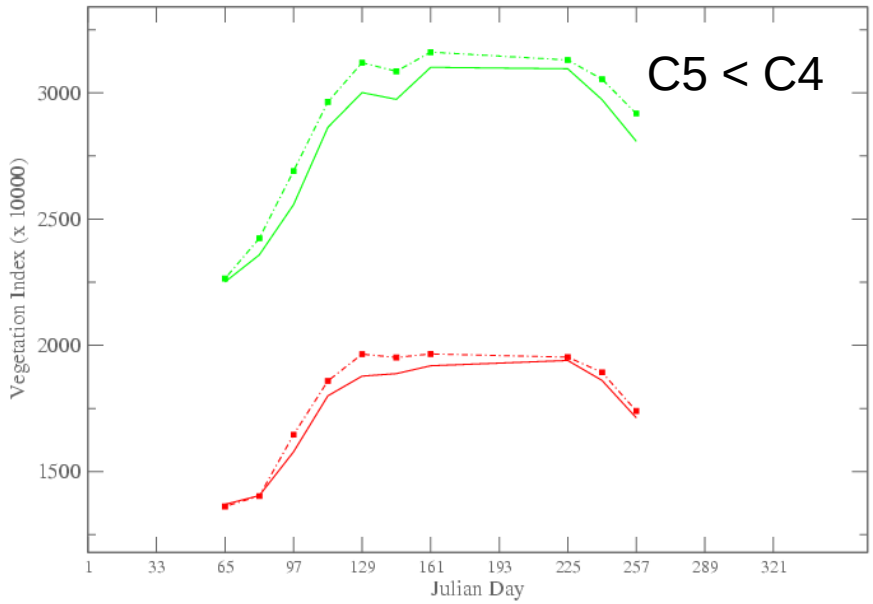
Terra C5 Vs. C5 Southwestern US Shrubland and Grassland Biomes (LDOPE)

Shrubland Biome
C4 dashed line, C5 solid line



Tue Jan 16 17:11:25 2007

Grassland Biome
C4 dashed line, C5 solid line



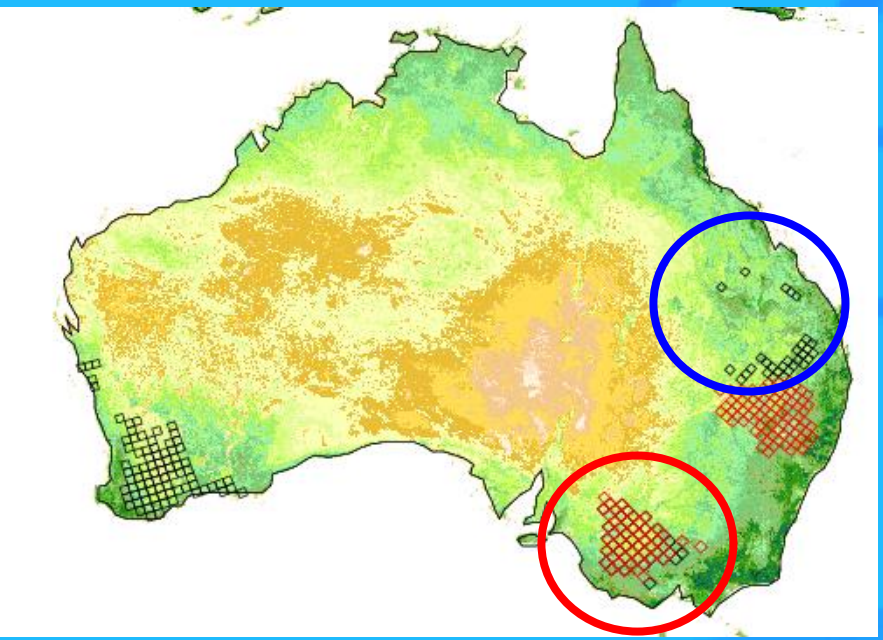
Tue Jan 16 17:11:23 2007

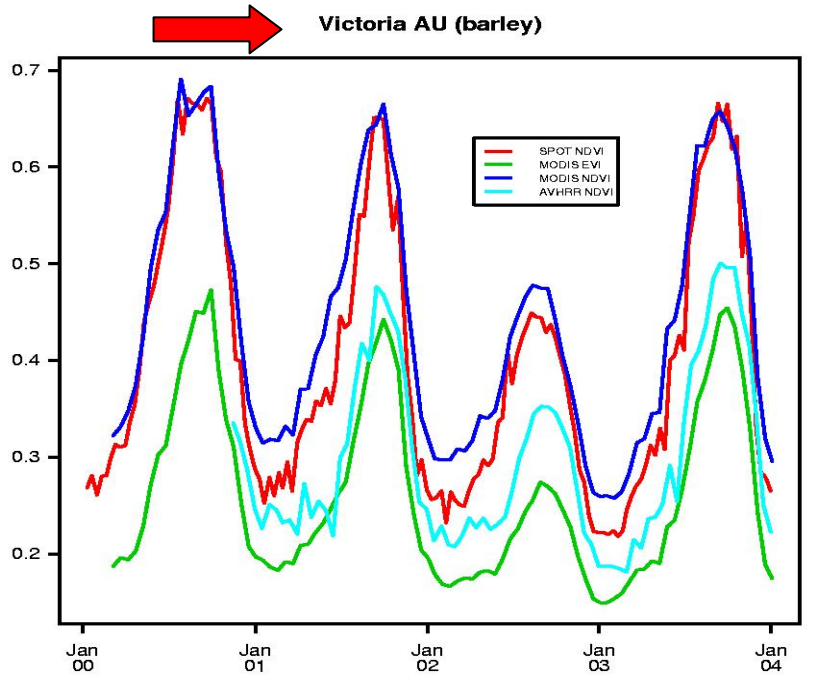
C4 – dashed line

EVI

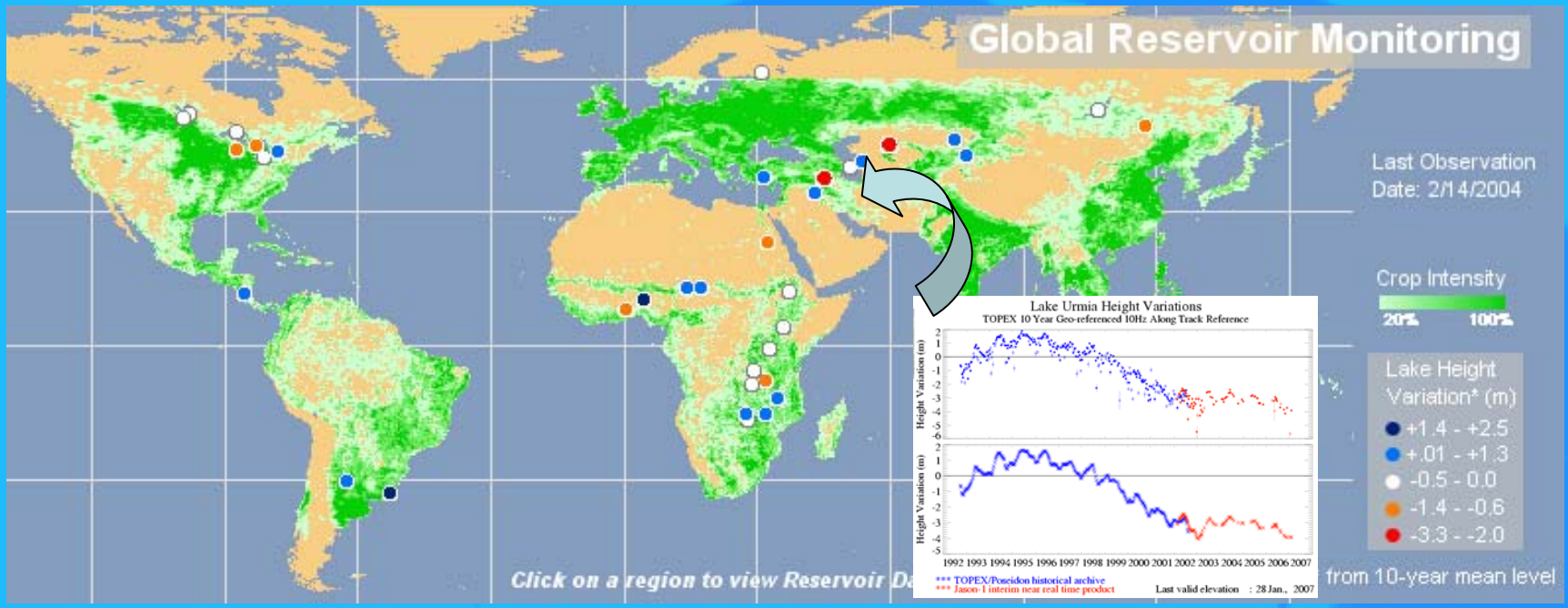
NDVI

Cross-Sensor Comparisons



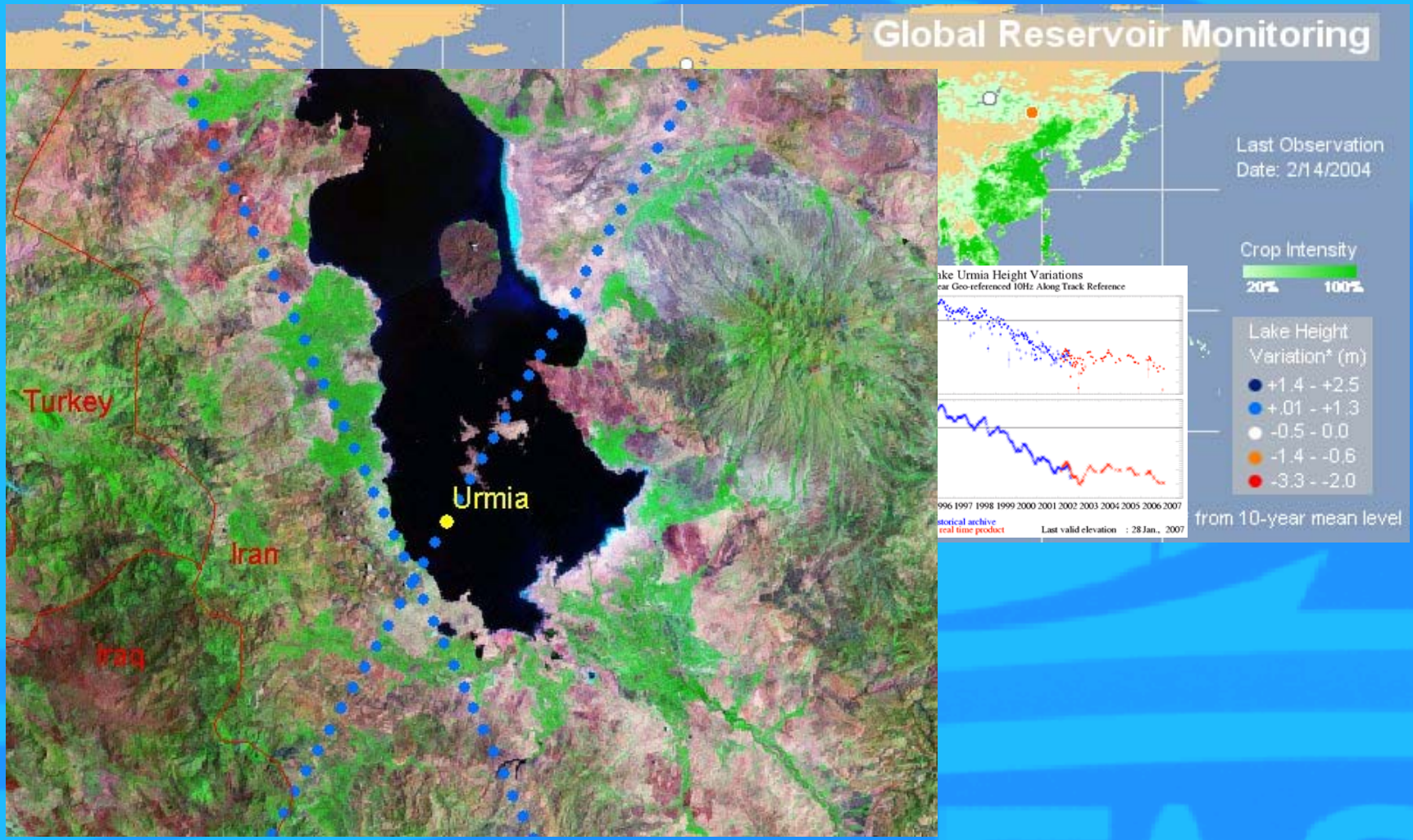


Global Reservoir and Lake Monitor



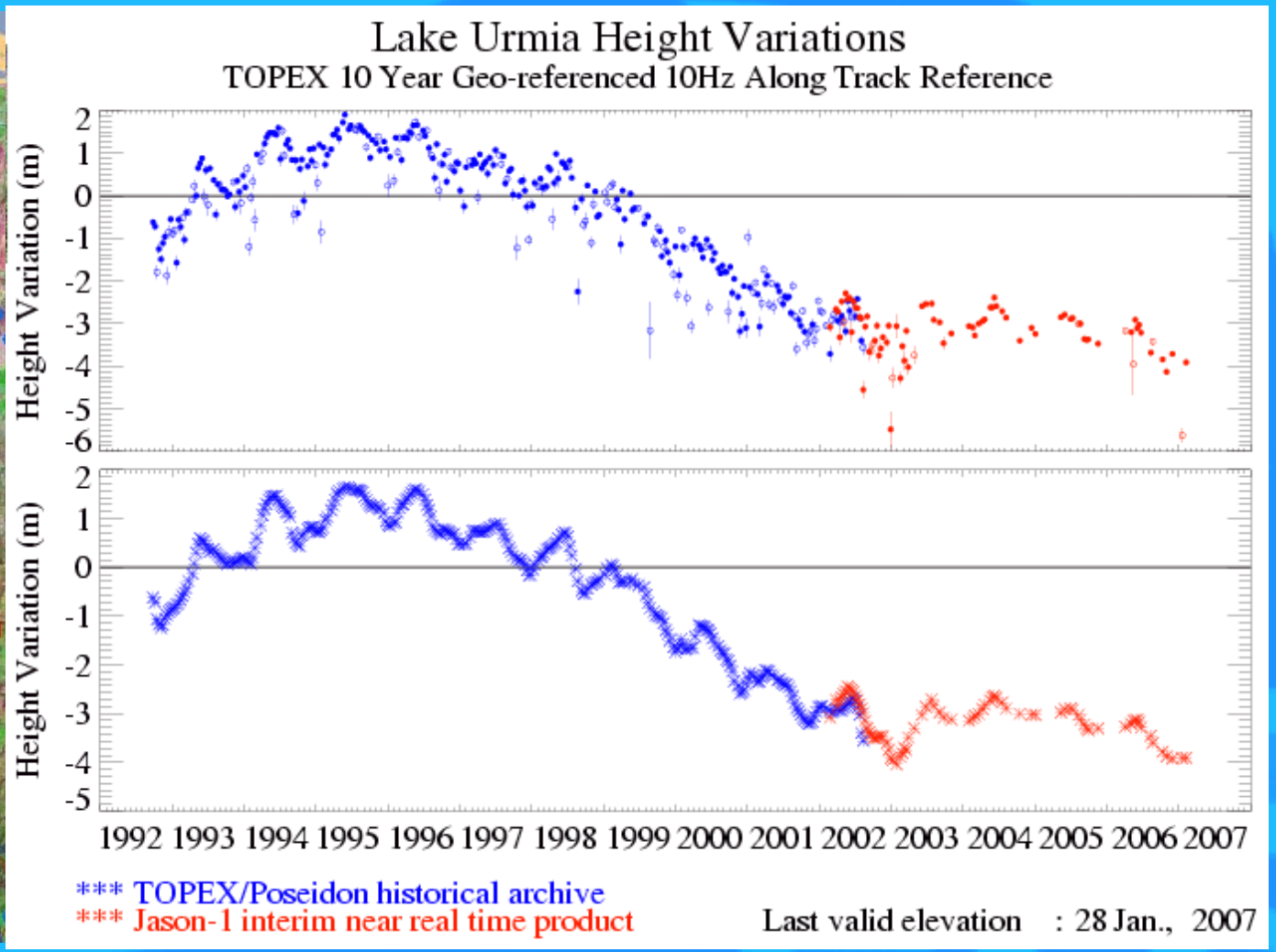
Reservoir Monitor connects satellites TOPEX/Poseidon and JASON-1 for altimeter data with Landsat data from the Landsat Global Visualization from USGS (GloVis). *An Integrated Geospatial Information Solution.*

Global Reservoir and Lake Monitor



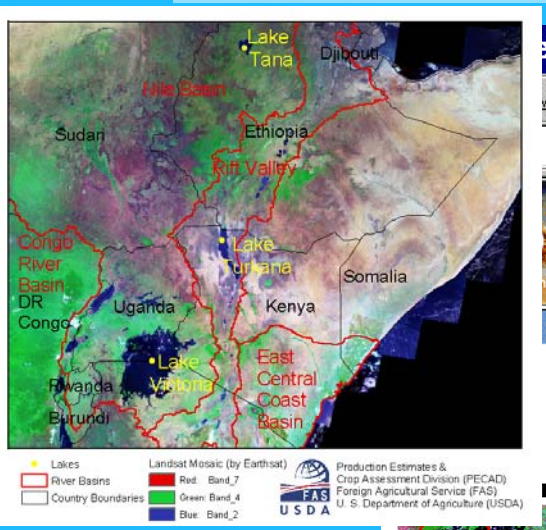
Reservoir Monitor connects satellites TOPEX/Poseidon and JASON-1 for altimeter data with Landsat data from the Landsat Global Visualization from USGS (GloVis). *An Integrated Geospatial Information Solution.*

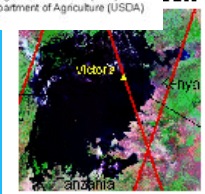
Global Reservoir and Lake Monitor



Reservoir Monitor connects satellites TOPEX/Poseidon and JASON-1 for altimeter data with Landsat data from the Landsat Global Visualization from USGS (GloVis). *An Integrated Geospatial Information Solution.*

Examples: Variation in Reservoir/Lake Heights





enlarge image

[LakeNet Profile]

[View Satellite Image]

[View 3D Image]

e Radar Altimetry: Global Reservoir and Lake Elevation Database - Lake Victoria - Microsoft I

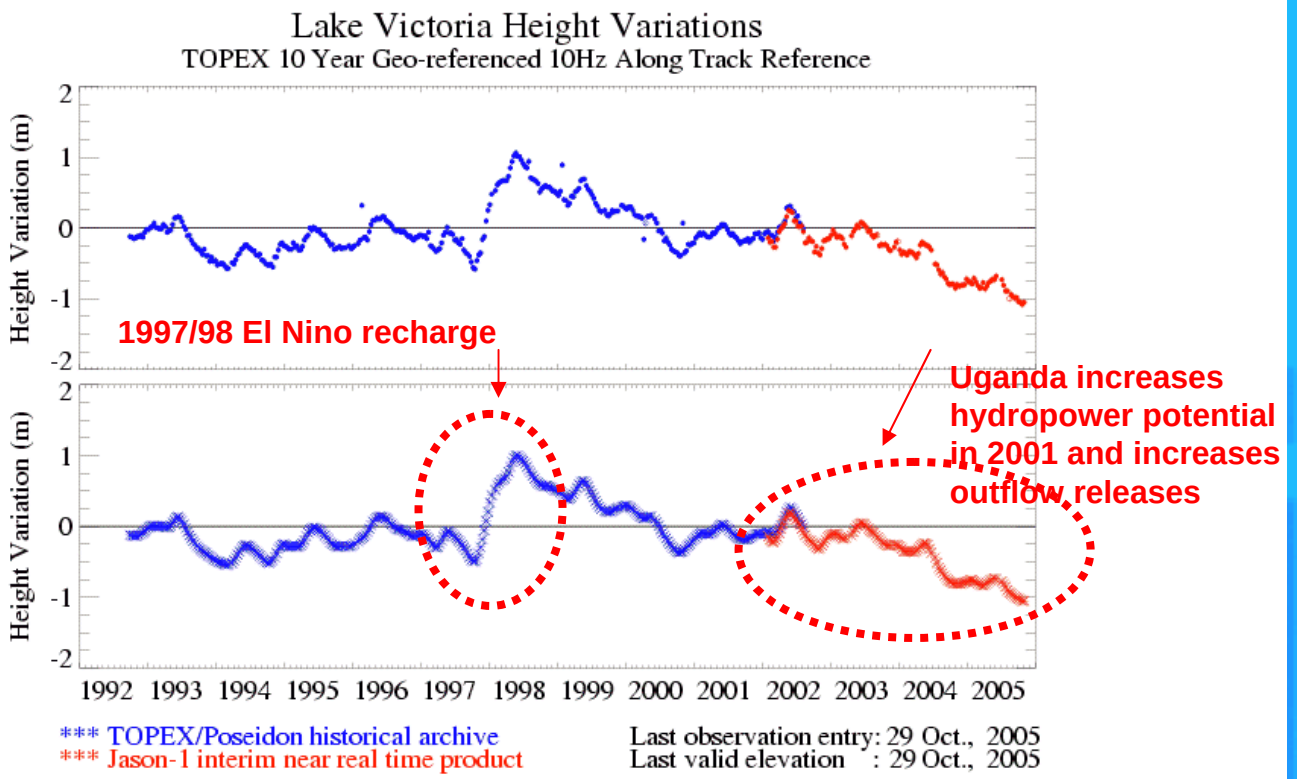
View Favorites Too » Back Search Favorites Media

http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir/gr_regional_chart.cfm?regionid=eafrica&region=&reservoir_name

Explorer

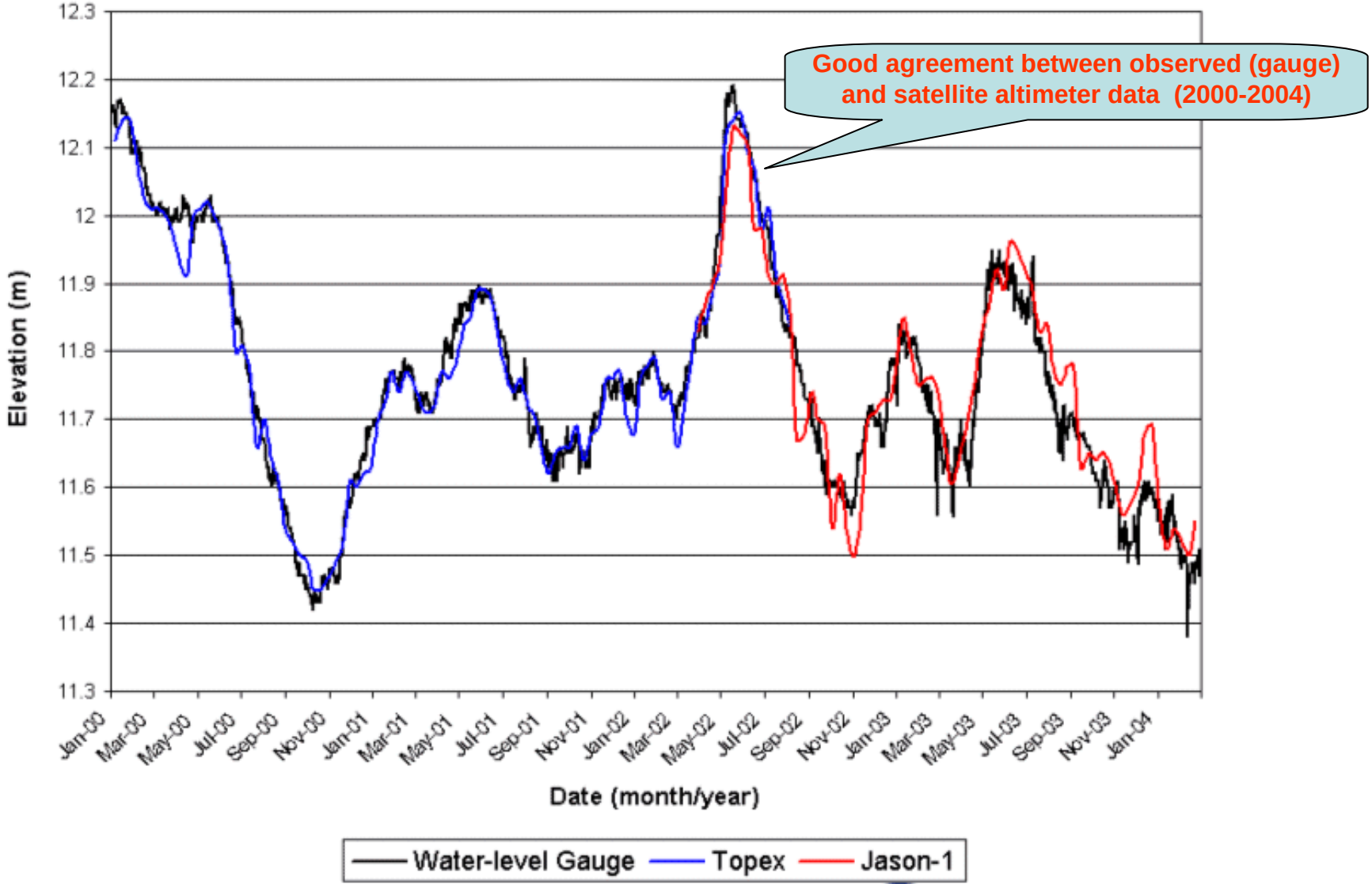
tes and Crop Assessment Division - Foreign Agricultural Service - USDA

Lake Level Variations from TOPEX/POSEIDON and Jason-1 Altimetry



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

Water-Level Gauge Measurements Compared to Satellite Radar Altimeter Observations



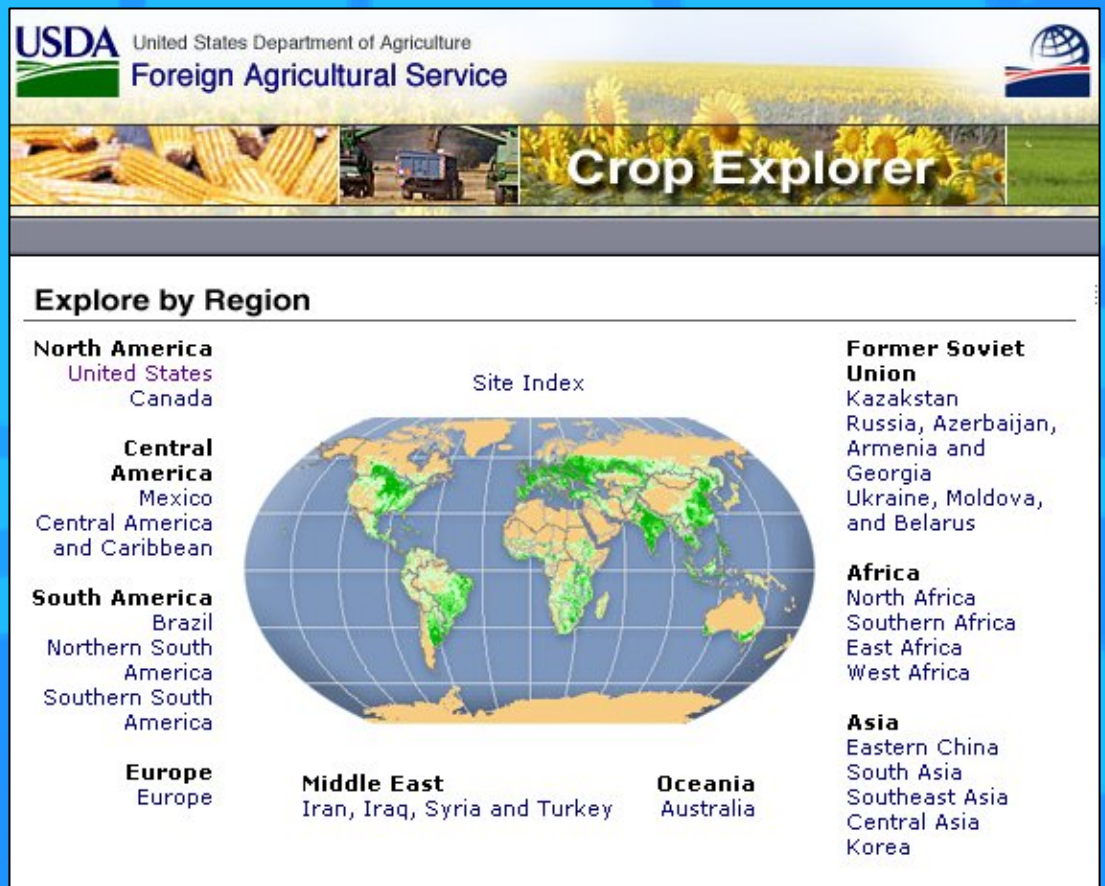
Data Source:
Water-level gauge data from Jinja, Uganda (near Lake Victoria's outlet)
Satellite radar altimeter data from USDS/NASA/UMD at:
http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir/

U.S. Department of Agricultural (USDA)
Foreign Agricultural Service (FAS)
Production Estimates & Crop Assessment Division (PECAD)

Making GLAM Work

Defined technology to DSS process

- Accepting the FAS DSS format
  - Crop Explorer (web portal)



CE: Template for Data Integration and Distribution

Responsible Organizations

USDA

NASA HQ

NASA GSFC (3 labs)

NASA Stennis

USGS

USAID

Raytheon

SSAI

ASRC

UMD

UA

UMo

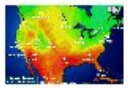
SDSU

ESRI Special Achievement In GIS Winner 2007

Wireless Quotes
CBOT Advantage
CBOT DataExchange
Real-Time Quotes & Charts
Commodity News for Tomorrow
Delayed Quotes & Charts
Time & Sales
Settlement Prices
Volume & OI
Reports
Historical Data
Historical Volatility
Commentaries
Delivery Reports
Liquidity Analyzer
Weather
Data Vendors
Market Data Online Billing

Weather as of October 5, 2006 6:05 PM


Four-Panel rainfall distribution map


Latest hour's temperatures


Yesterday's high temperatures


Latest month-to-date rainfall totals

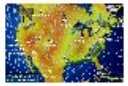

Latest windchill temperature values


Forec next


Lates


Lates totals


Lates norm.


Lates knots

US Regional Radar Maps

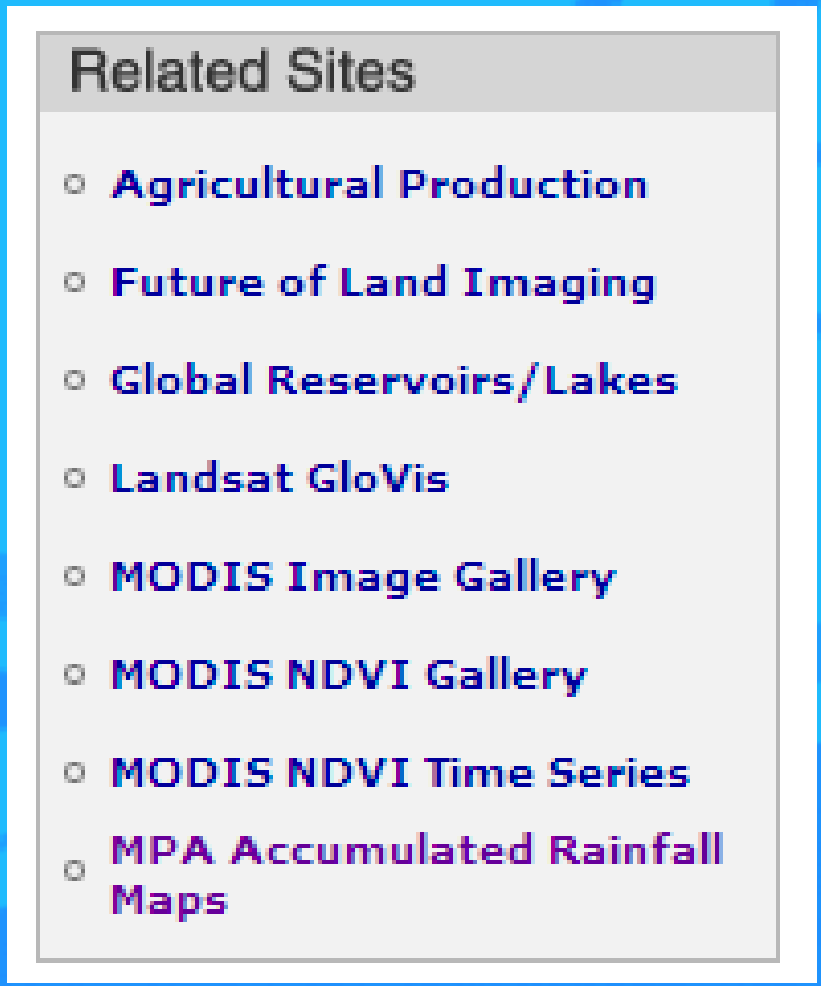
The Crop Explorer Web Site features near-real-time global crop condition information based on satellite imagery and weather data. Thematic maps of major crop growing regions depict vegetative vigor, precipitation, temperature, and soil moisture. Time-series charts depict growing season data for specific agro-meteorological zones. Regional crop calendars and crop area maps are also available for selected regions.

http://www.pecad.fas.usda.gov/cropexplorer/index.cfm

USDA United States Department of Agriculture
Foreign Agricultural Service

Production Estimates and Crop Assessment Division

Technology Transfer from Space Agencies through USDA FAS to Agricultural Audience



- **In CY2008 planned <u>USDA "footprint"</u> at NASA/GSFC:**
  - **to produce global agriculture information products from NASA data streams.**
  - **prepare processing systems for NPOESS**

Other new/proposed GLAM activities

- **Irrigated agriculture assessments(pending)**
  - University of Wisconsin
- **Enhanced/high-resolution global precipitation modeling**
  - USAF and NASA
- **High resolution imagery**
  - Field-sampling/area-frame strategies
  - Supplementing ground-truth

NGA-OGA COLLABORATION IN IRAQ PROVIDING ANALYSIS AND DATA PRODUCTS FOR US AND IRAQ DECISION MAKERS

MODERATE RESOLUTION PROVIDES
LARGE REGIONAL COVERAGE MULTIPLE TIMES
DURING THE GROWING SEASON

JACIE March 25, 2008

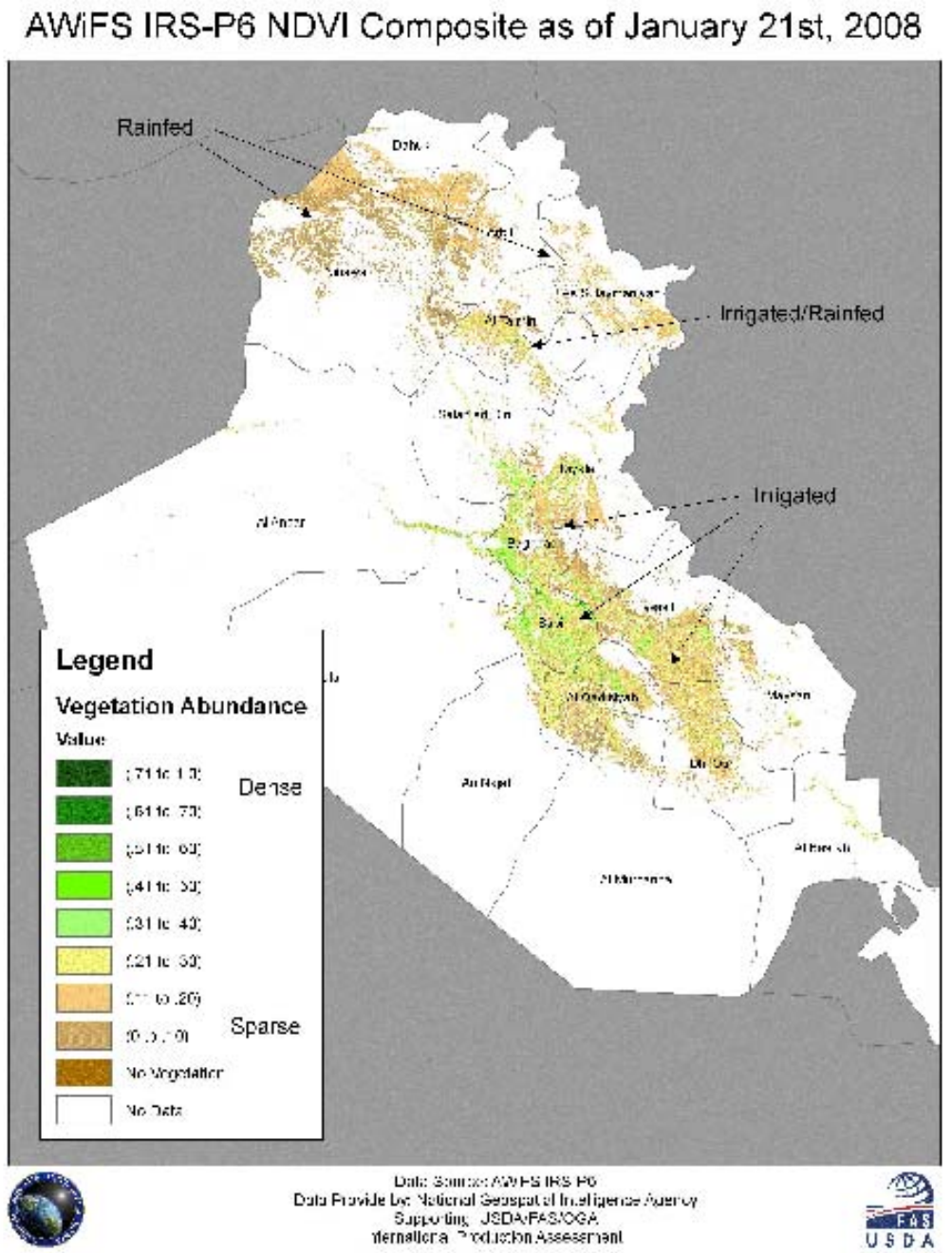
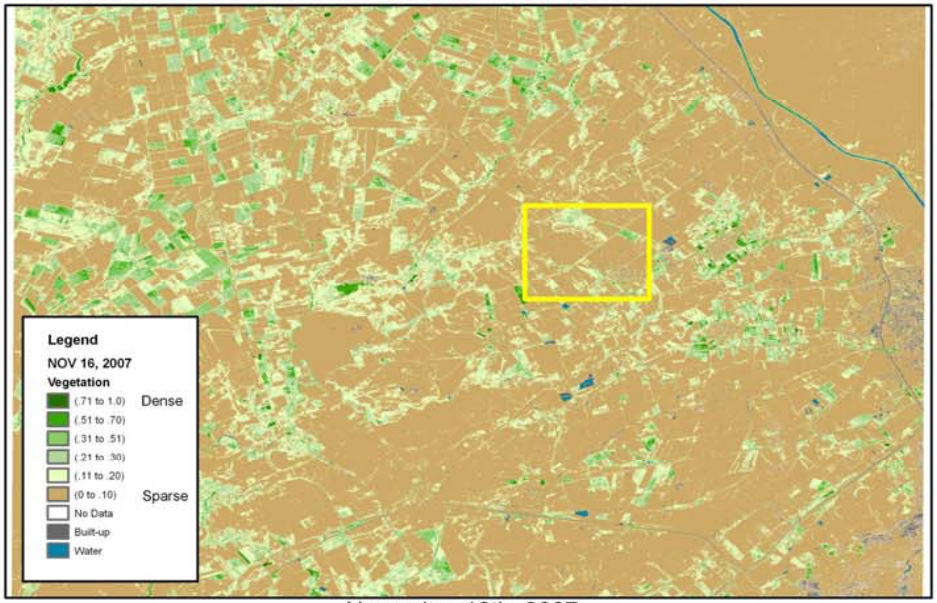
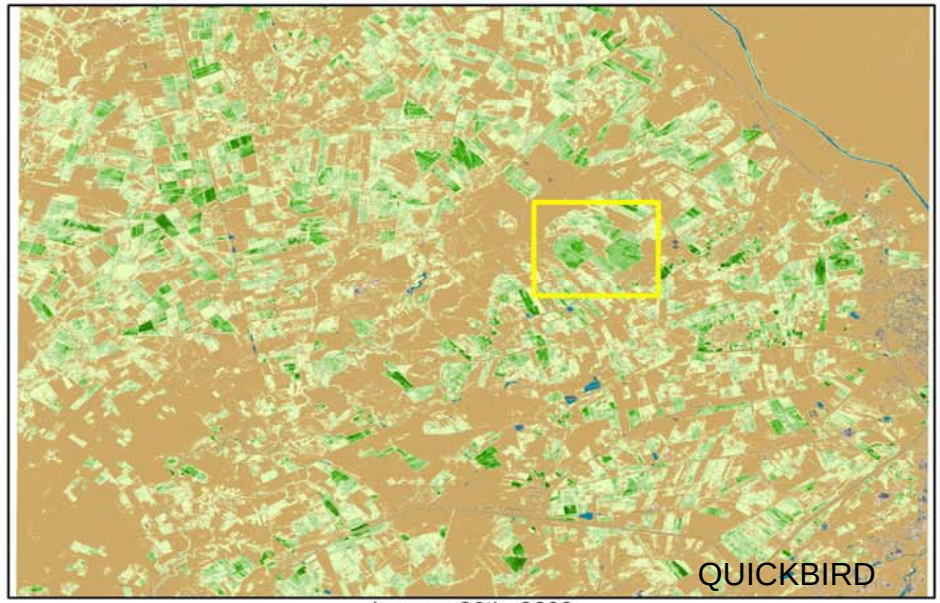


Figure 5: NDVI composite revealing highest crop abundance in irrigated regions. Rainfed areas reflect sparse vegetation only.

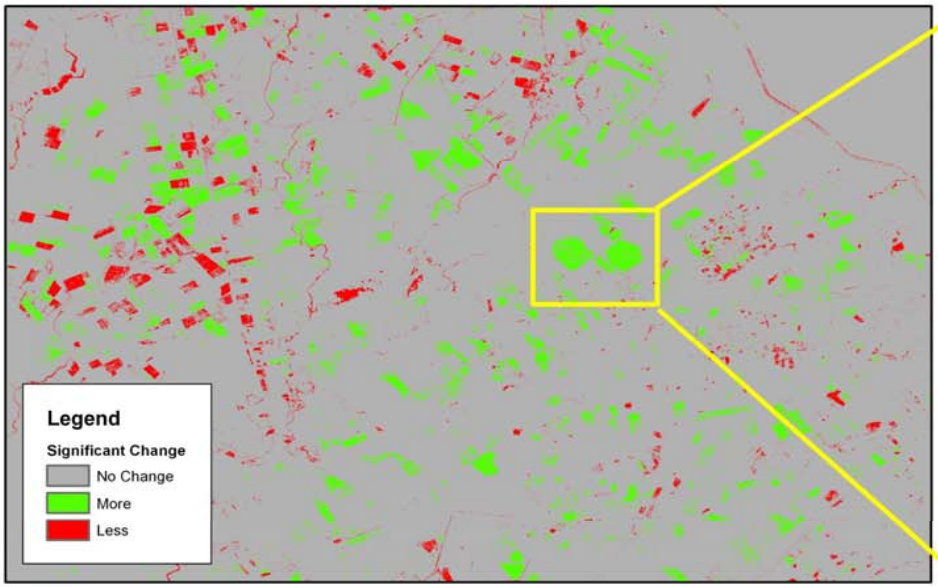
Changes in Vegetation Abundance from Nov 16th, 2007 to Jan 20th, 2008 (AOI 16, Salah ad Din)

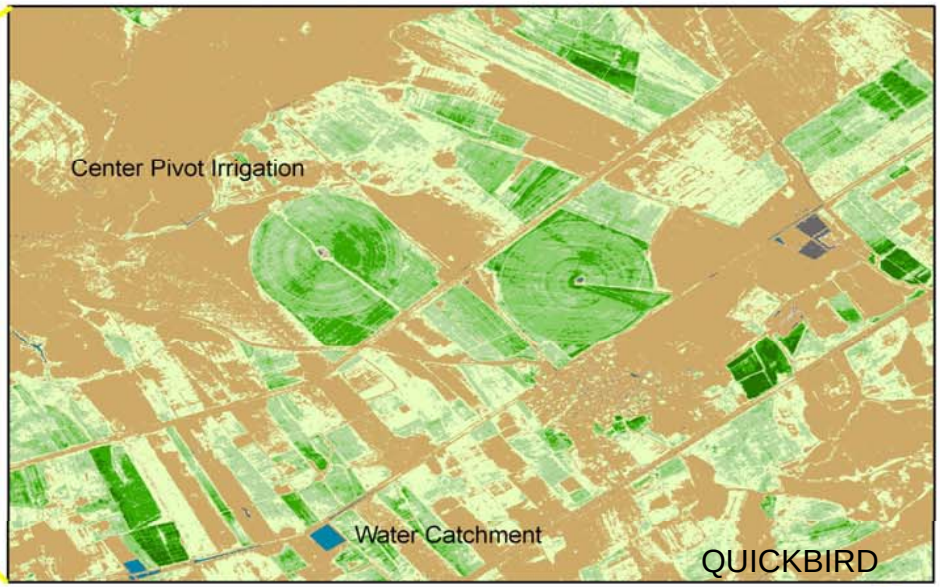


November 16th, 2007



January 20th, 2008





Data Source: Quickbird MS
Data Provided by: National Geospatial Intelligence Agency
Supporting: USDA/FAS/OGA
International Production Assessment

FAS missions

performed by OGA through funding from the Remote Sensing Program

- **Global Crop Production Intelligence and Analysis-** *core mission (CCC, CFR)*
  - World Agriculture Production (WAP)
  - Primary international input to World Agriculture Supply and Demand Estimates (WASDE)
  - Market and Food Security Intelligence/Analysis
- **FSA Early Warning and Crop Conditions-** *Department program efficiency (CCC, MOU)*
  - Direct report to FSA administration
- **USDA Satellite Imagery Archive (SIA)-** *Department program efficiency (CCC, MOU, CFR)*
  - USDA space program leadership and centralized acquisition management

USDA-Satellite Imagery Archive (USDA-SIA)

ACCESS

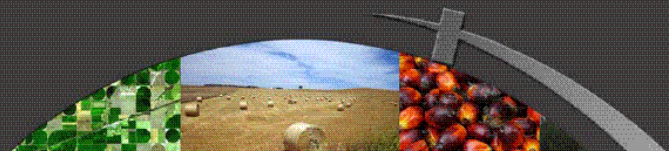
Global Agriculture Monitoring

in the framework of Group on Earth Observations ***(GEO)*** *16-18 July 2007*

- Hosted at FAO and led by NASA
- Findings prepared for Nov 2007 Ministerial
  - http://www.fao.org/gtos/igol/docs/meeting-reports/07-GEO-AG0703-Workshop-Report-nov07.pdf
- Chair-Dr. Chris Justice, UMD
- Dep. Chair-rotating
- UN-Global Agriculture Monitoring representative at GEOS Secretariat -(India and China-pending)
- EU/Joint Research Center hosting “National Agriculture Monitoring Community of Best Practices Workshop” in June 2008.

http://www.fao.org/gtos/igol/docs/meeting-reports/07-GEO-AG0703-Workshop-Report-nov07.pdf

Developing a Strategy for Global Agricultural Monitoring in the Framework of Group on Earth Observations (GEO) Workshop Report



Workshop funded and organized by University of Maryland, NASA, USDA/FAS, UN FAO, and the GEO Secretariat

and hosted by the UN FAO NRCE

GROUP ON EARTH OBSERVATIONS

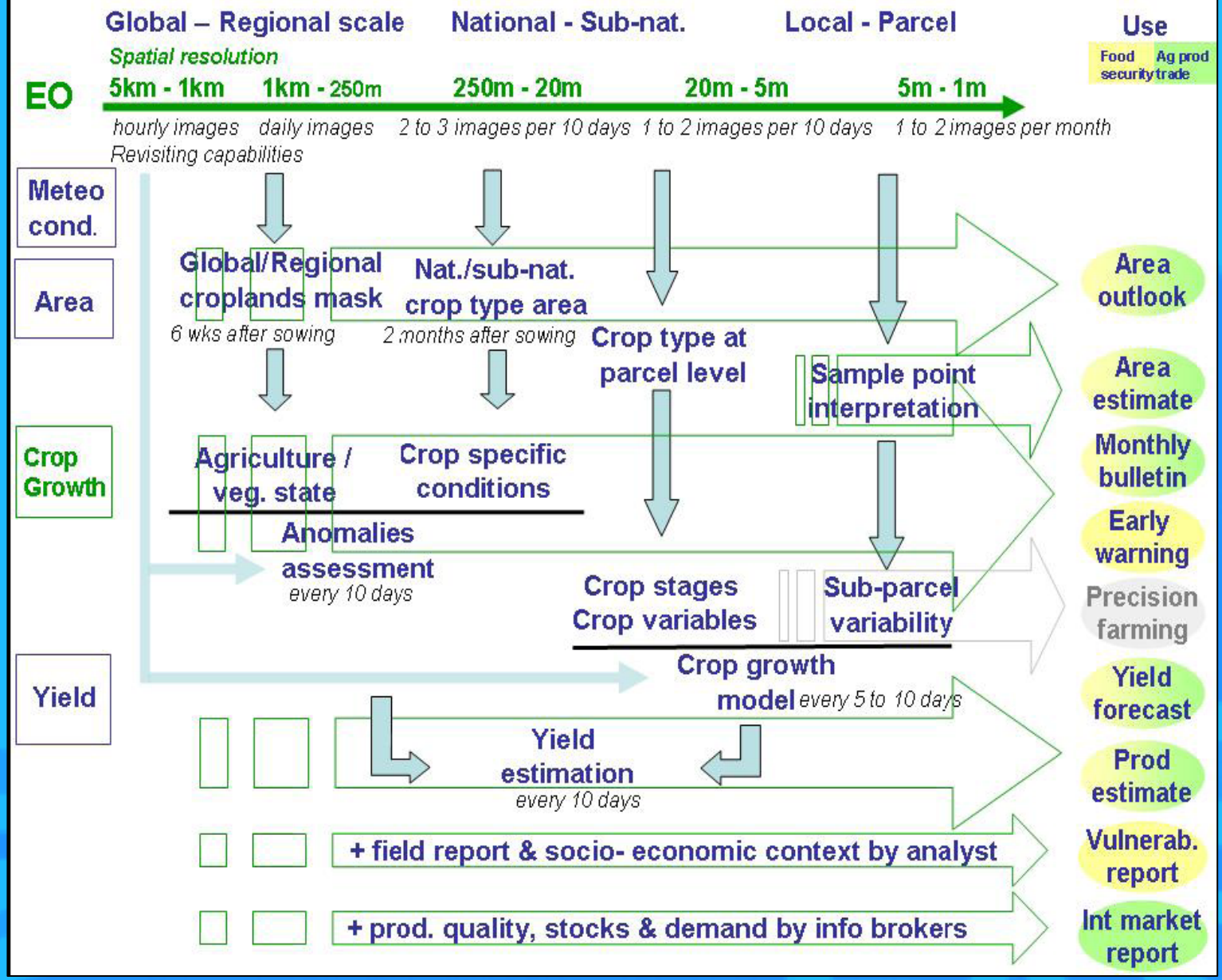
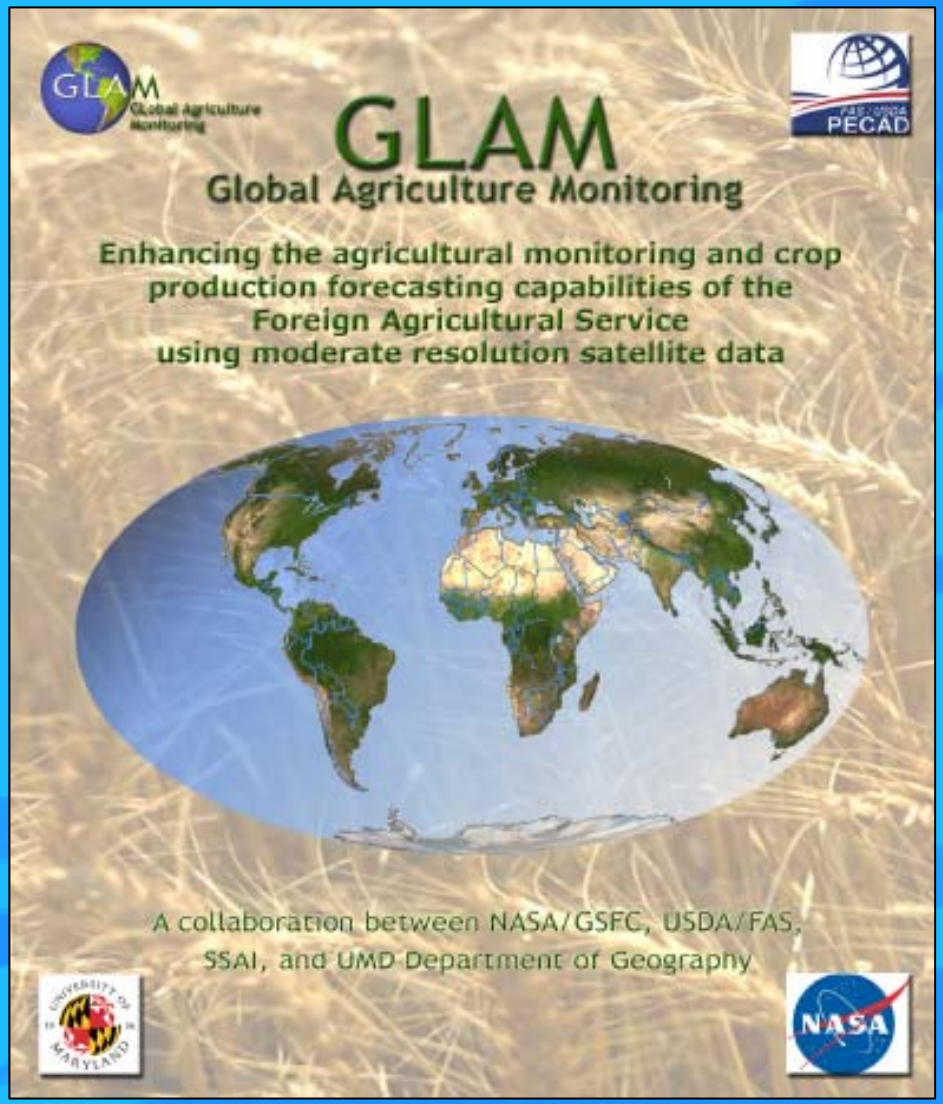


Figure 4. *A schematic of the inputs and outputs for the Global Agricultural Monitoring System of Systems.*



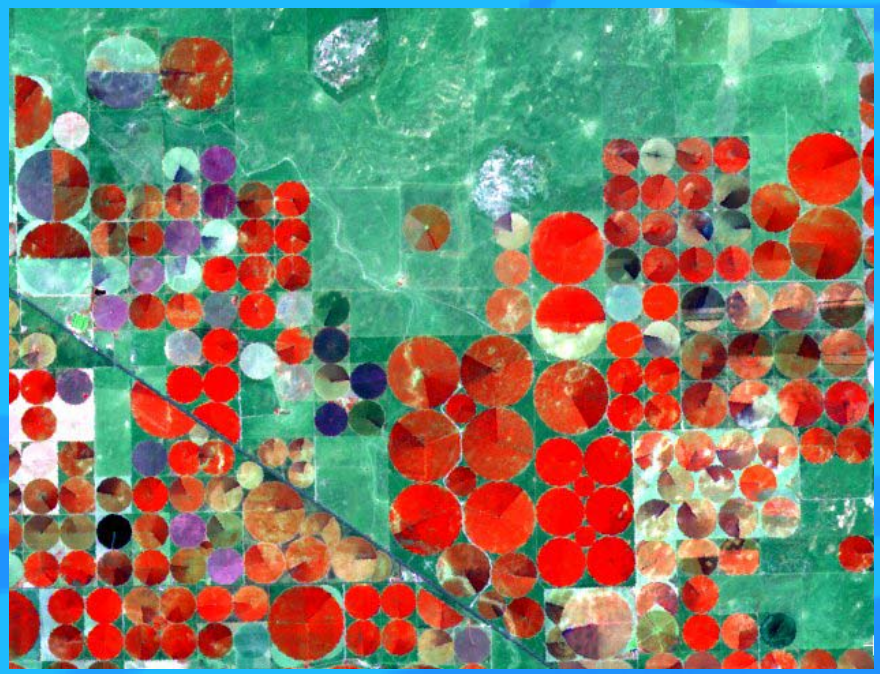
GLAM is the NASA-USDA led partnership to leverage NASA technology to improve the FAS global agriculture monitoring and reporting mission.

QUESTIONS

BACKUP SLIDES

Mission:

To produce the most objective and accurate assessment of global agricultural production and conditions affecting food security in the world.



26-Year History. **Programs and archived data from 1979 (LACIE-AgriStars)**

Responsible for Deriving a US Principle Federal Economic Indicator

FAS missions

performed by OGA through funding from GLAM and the Remote Sensing Program

- **<u>Global Crop Production Intelligence and Analysis</u>-** *core mission (CCC, CFR)*
  - World Agriculture Production (WAP)
  - Primary international input to World Agriculture Supply and Demand Estimates (WASDE)
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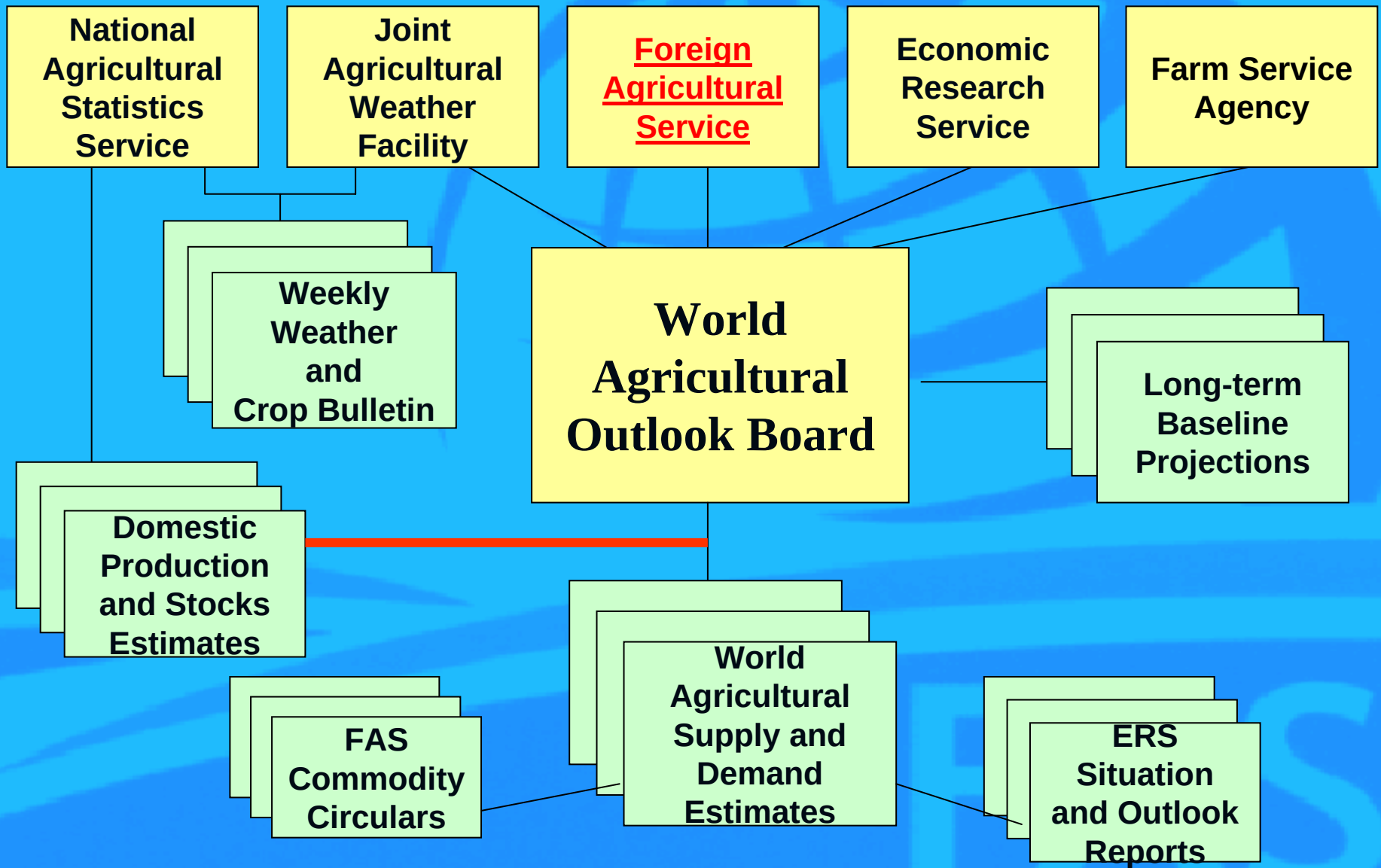
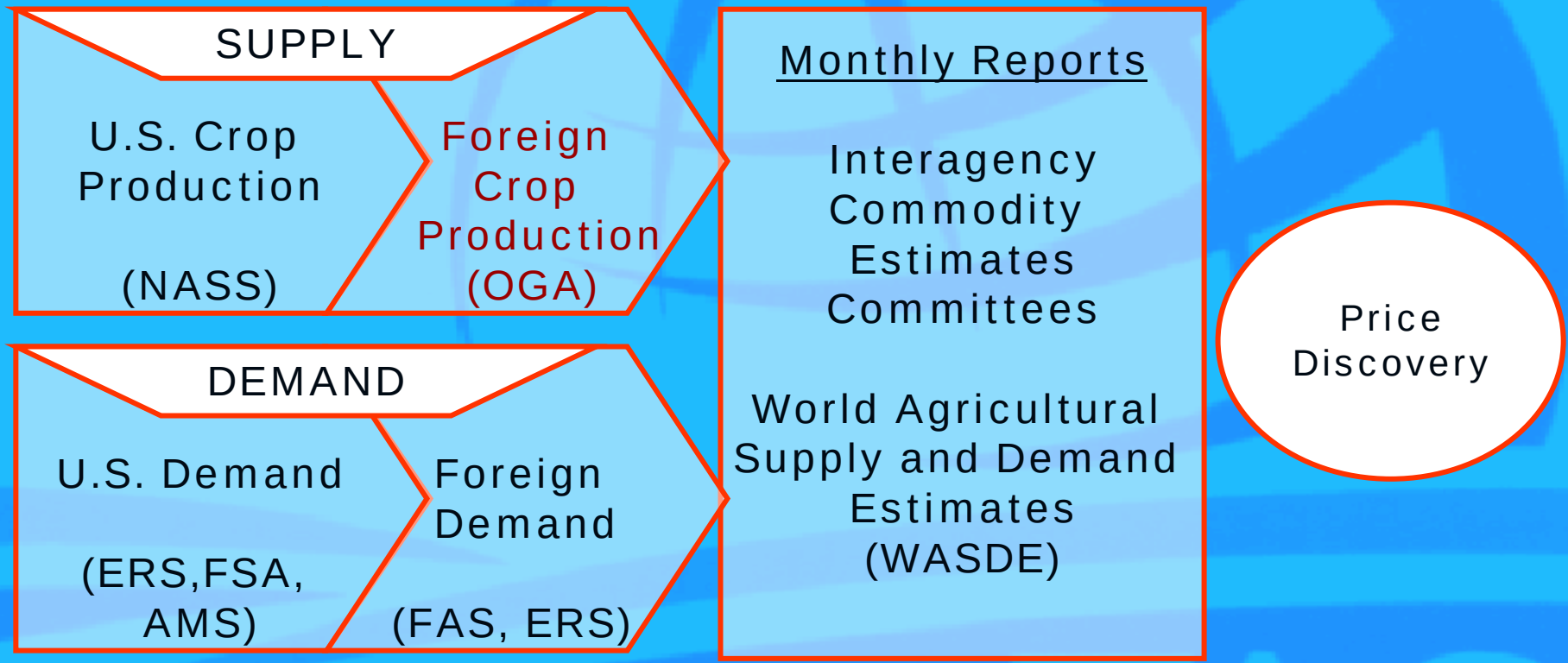
  - USDA space program leadership and centralized acquisition management

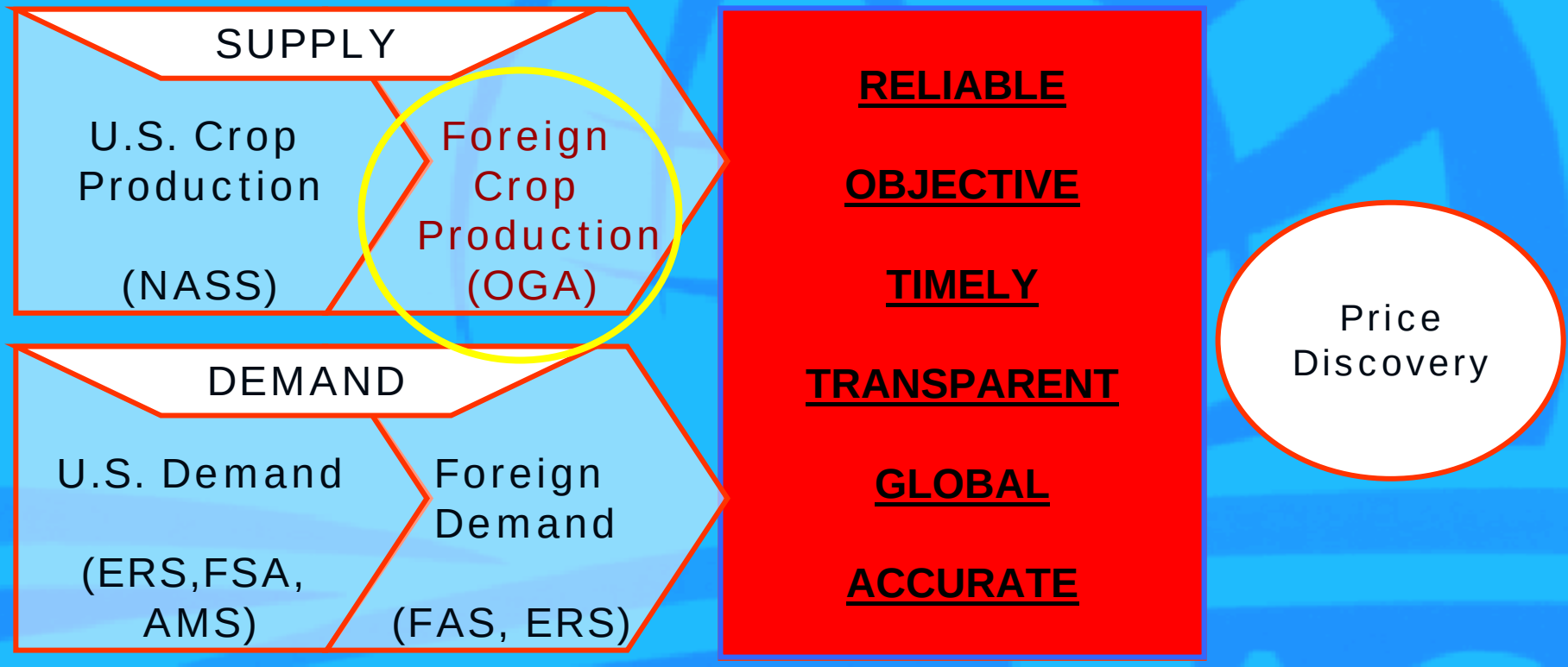
USDA's Economic Information System



Global Agriculture Intelligence and Reporting Role



Global Agriculture Intelligence and Reporting Role



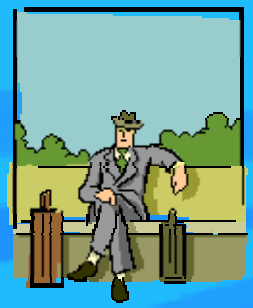
Convergence of Evidence, All-Source Methodology

FAS Attaché Ground Truth

Land Surface
Remote Sensing

Atmospheric
Remote Sensing

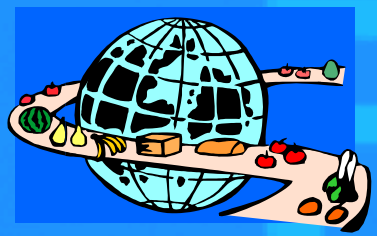
IPA
-Analysts
-RS
-GLAM



Ground Truth

External Ground Truth
(Cntry Rpts/News Services)

Global Food Supply



US Ag Industry
US Trade Industry
US Gov't Policy Makers

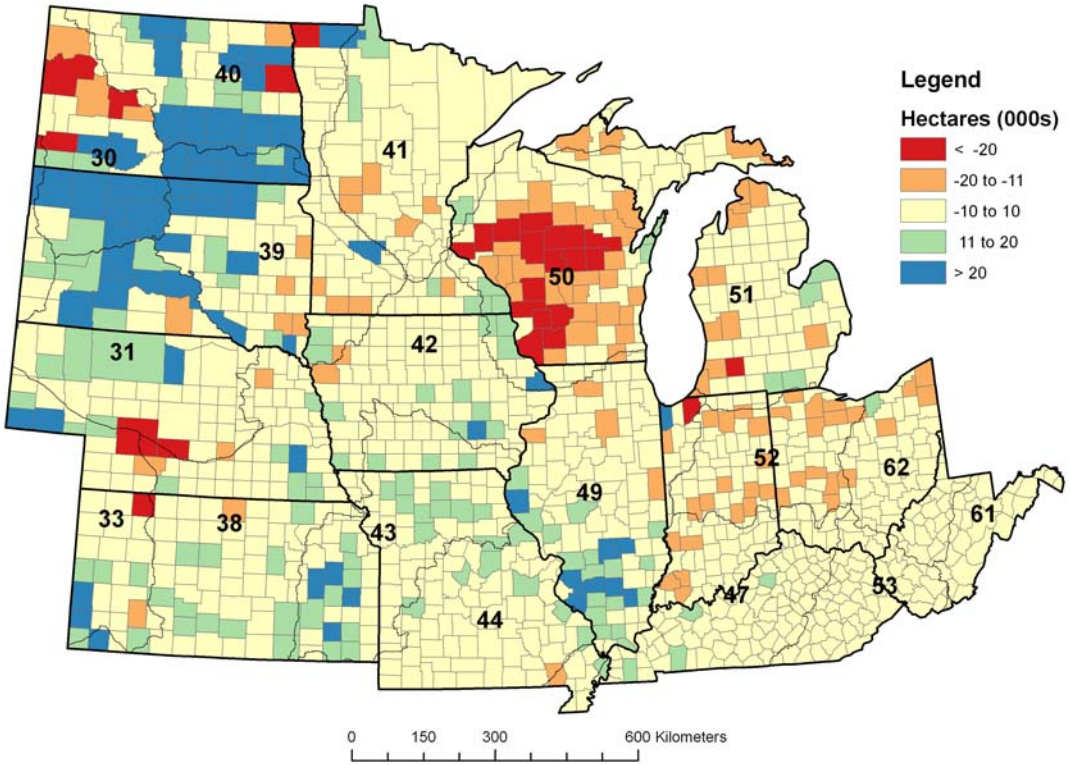


Figure 2a Hectares difference between 2002 USDA Census of Agriculture and 2001 NLCD cropland estimate at the county level. Counties represented in orange and red colors are where the NLCD estimates were higher than the Census estimate. Counties represented in green and blue colors are where the NLCD estimates were lower than the Census estimate.

Figure 2a Hectares difference between yesterday's Country X official reports and news wires and FAS-OGA analysis at the sub-national level.

An Analogy of OGA Role in Reporting Process

Commercial Space sources

US Government Space Agency sources

Satellite Imagery

SPOT IMAGE

Australian Government Geoscience Australia

SPACE IMAGING Visual Information. Visible Results.

DIGITALGLOBE

RADARSAT INTERNATIONAL

EARTHSAT

eurimage

GeoEye

+11 satellites

+13 satellite ground processing stations

Commercial Contracts

Cost-Reimbursement Agreements

Technology Transfer

Cost Reimbursement Agreements

NOAA

U.S. AIR FORCE

NASA

U.S. DEPARTMENT OF THE INTERIOR MARCH 3, 1849

FAS Global Crop Production Information

CADRE

Attache Reports

News Services

Other Intel.

Crop Travel

Weather Stations

Analysis

Producers

Agri-business

USDA Satellite Imagery Library

EGOV

SAT. IMAGERY

Satellite imagery redistribution

Saves Millions

USDA Farm Service Agency

CropExplorer

Updates

FASNET

WAP

World Agriculture Production

OPERATIONAL PROCESS OVERVIEW

NASS

FOREST SERVICE

APHIS

USDA NRCS Natural Resources Conservation Service

OFFICE OF INSPECTOR GENERAL USDA

RMA

JACIE March 25, 2008

Customer Summary

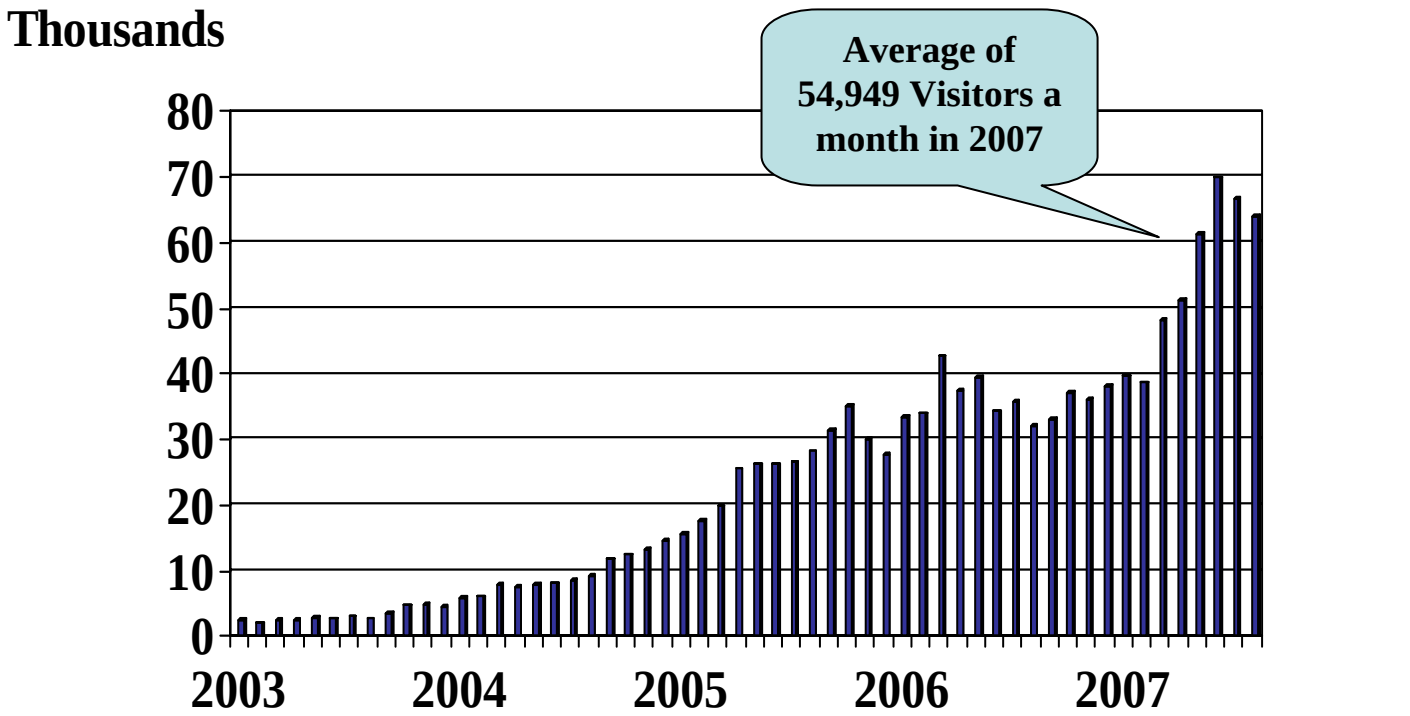
Public/Stakeholders

- **Academia**
- **Private Sector**
- **Government**
- **featured on 100's of web-sites, e.g. Chicago Board of Trade, John Deere, Cargill,....**

USDA SIA Members

- **APHIS**
- **FSA**
- **RMA**
- **ARS**
- **NASS**
- **USFS**
- **CSREES**
- **FAS**
- **USGS**
- **International Partners**

Visits to Crop Explorer



Source: WebTrends Monthly Report
Data through Aug. 31, 2007

FAS missions

performed by OGA through funding from the Remote Sensing Program

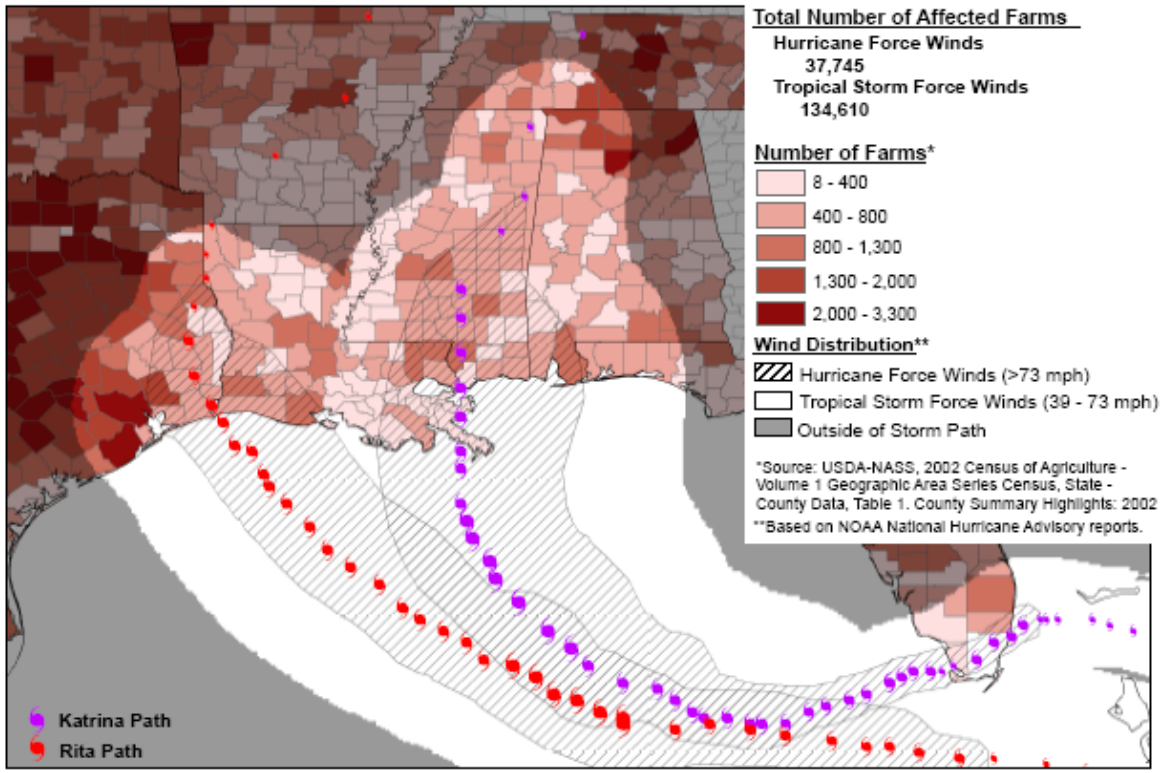
- **Global Crop Production Intelligence and Analysis-** *core mission (CCC, CFR)*
  - World Agriculture Production (WAP)
  - Primary international input to World Agriculture Supply and Demand Estimates (WASDE)
  - Market and Food Security Intelligence/Analysis

- **FSA Early Warning and Crop Conditions-** *Department program efficiency (CCC, MOU)*
  - Direct report to FSA administration

- **USDA Satellite Imagery Archive (SIA)-** *Department program efficiency (CCC, MOU, CFR)*
  - USDA space program leadership and centralized acquisition management

August 2005 Early Warning Analysis

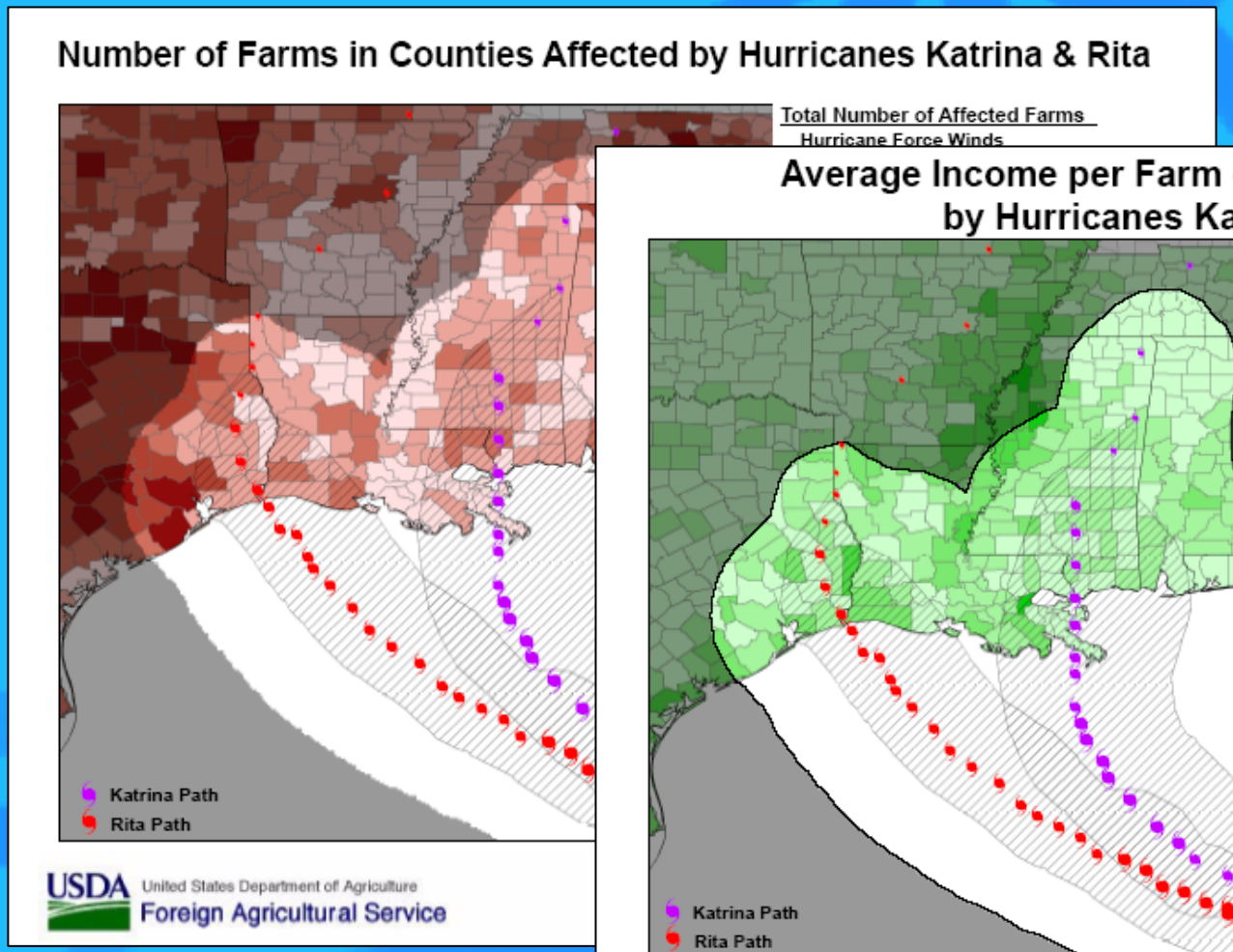
Number of Farms in Counties Affected by Hurricanes Katrina & Rita

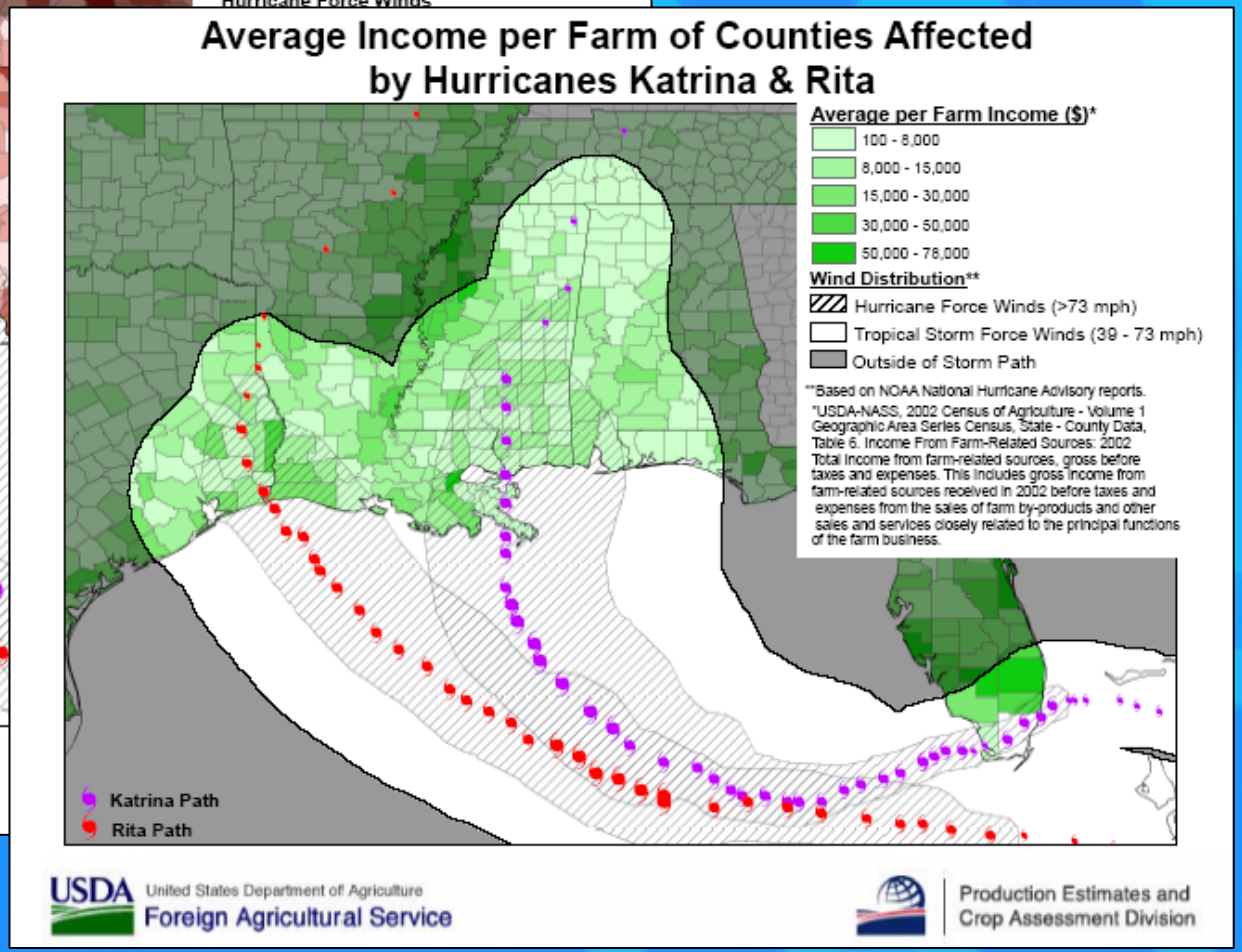


USDA United States Department of Agriculture
Foreign Agricultural Service

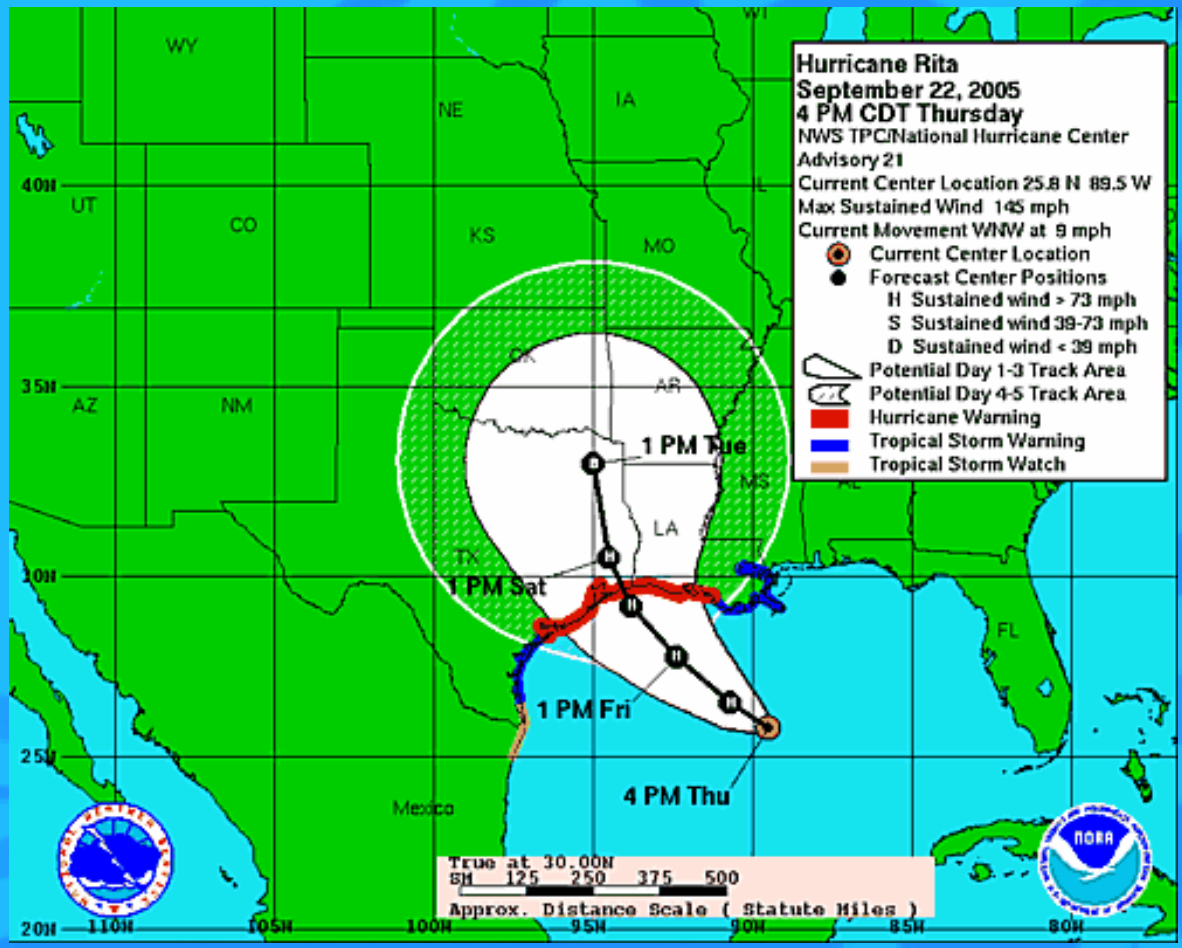
Production Estimates and Crop Assessment Division

August 2005 Early Warning Analysis





Hurricane Analysis WITHOUT Remote Sensing Program



NOAA Weather Map

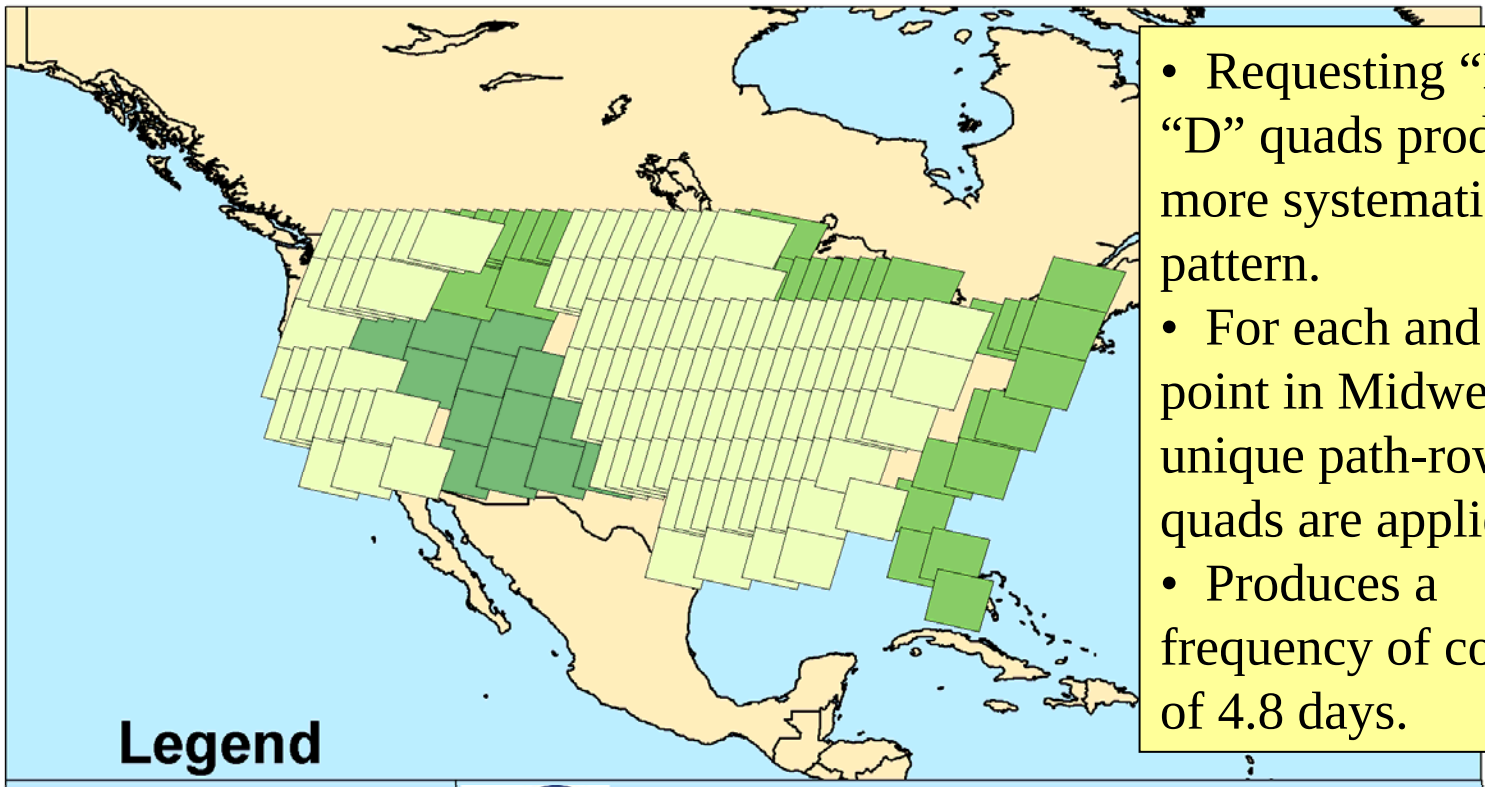
USDA Plans for FY2008

- Continue purchasing Resourcesat-1-AWiFS.
- USDA agency meeting to plan out US coverage.
- Real Product Innovation
  - Higher efficiency of scene use (remove clouds)
  - Updated mosaics of critical areas
  - Accessible products
- Possible expansion for winter coverage (dependent on new source of funding)
  - Winter wheat classification—NASS.
  - Pasture and rangeland crop insurance—RMA.

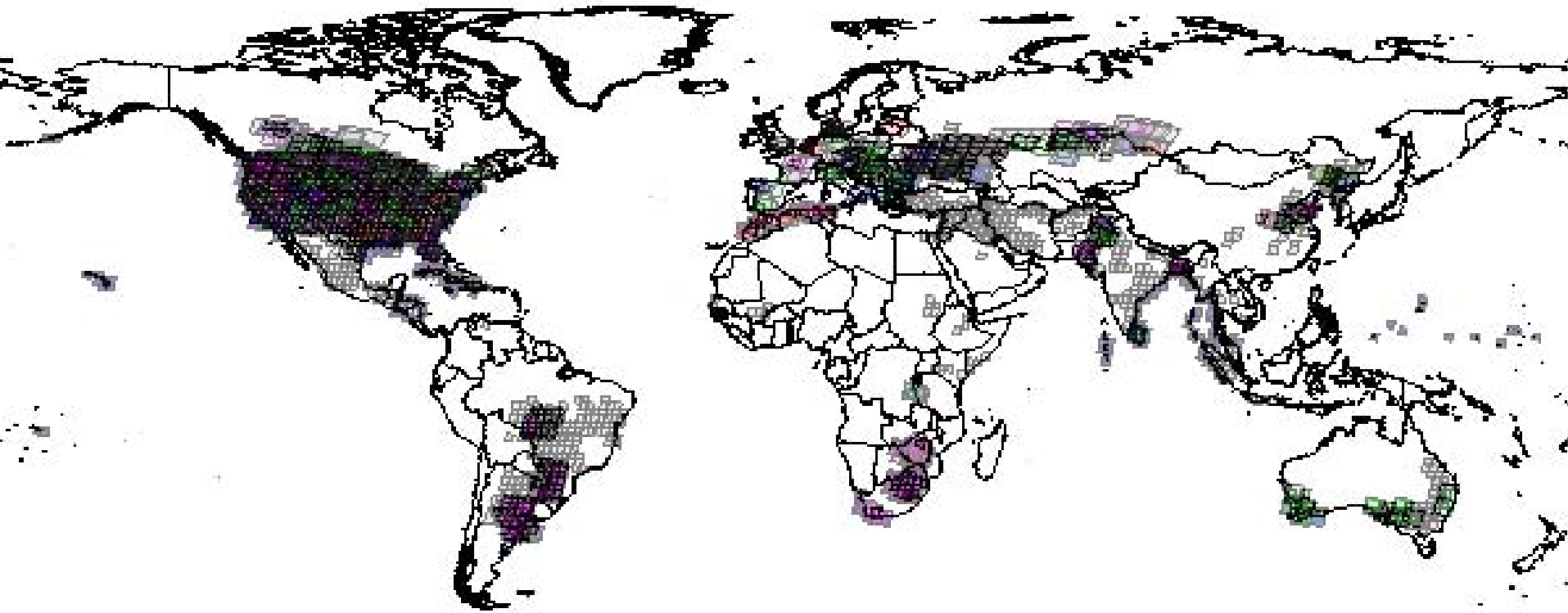
FY 2008 Plans for US Coverage

- When? Coverage April 1, 2008 to September 30, 3008
  - The plan is for the same temporal pattern as in FY2007
  - Does this suit everyone?
  - Should there be less April and more July and August quads?
- What? “B” and “D” quads
  - Should we add in more “A” and “C” quads?
- Bit Depth
  - The plan is to continue 8-bit products.
  - Should we move to 10-bit?
- Funding Source:
  - Continue to rely on Commodity Credit Corporation
  - Are there additional funds?
- USDA-SIA will send shapefile to agency reps by mid-December.
- Comments/ suggestions for meeting in February

USDA's US Standing Order: Resourcesat-1 AWiFS in FY2007
June 1 to Sept. 30



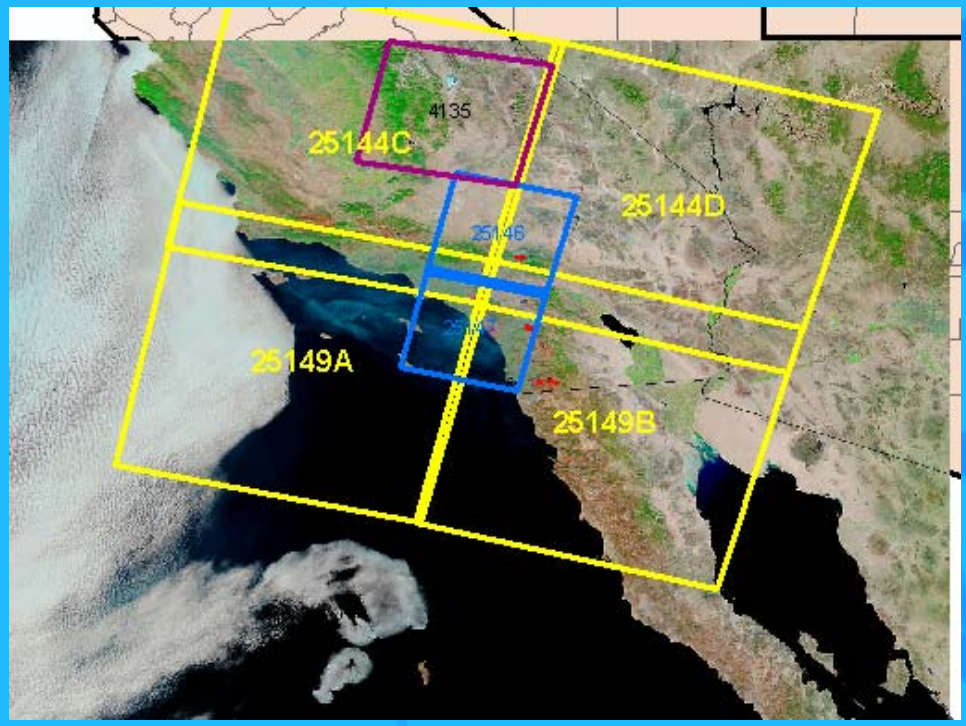
- Requesting "B" and "D" quads produces a more systematic pattern.
- For each and every point in Midwest, 5 unique path-row-quads are applied.
- Produces a frequency of coverage of 4.8 days.



Global Coverage of the USDA Satellite Imagery Archive
[gray boxes are Landsat scenes; colored boxes are AWIFS & LISS3]

Satellite Sensor	Number of Images
AVHRR	15,666
AVHRR	1,159
COMPOSITE	3,062
AWIFS	39
LISS-3	26,419
LANDSAT	2,696
SPOT	

JACIE March 25, 2008



Comparison of coverage between Landsat, P6-LISS3, and P6-AWIFS.
[MODIS background image of Southern California and Baja Peninsula 10/25/2007]

Landsat
30m resolution
185 x 170 km swath

P6-LISS3*
23.5m resolution
141 x 141 km image swath

P6-AWiFS*
56m resolution
350 x 350km image swath

*Indian Remote Sensing Satellite
(IRS-Resourcesat)
Vendor: GEOEYE

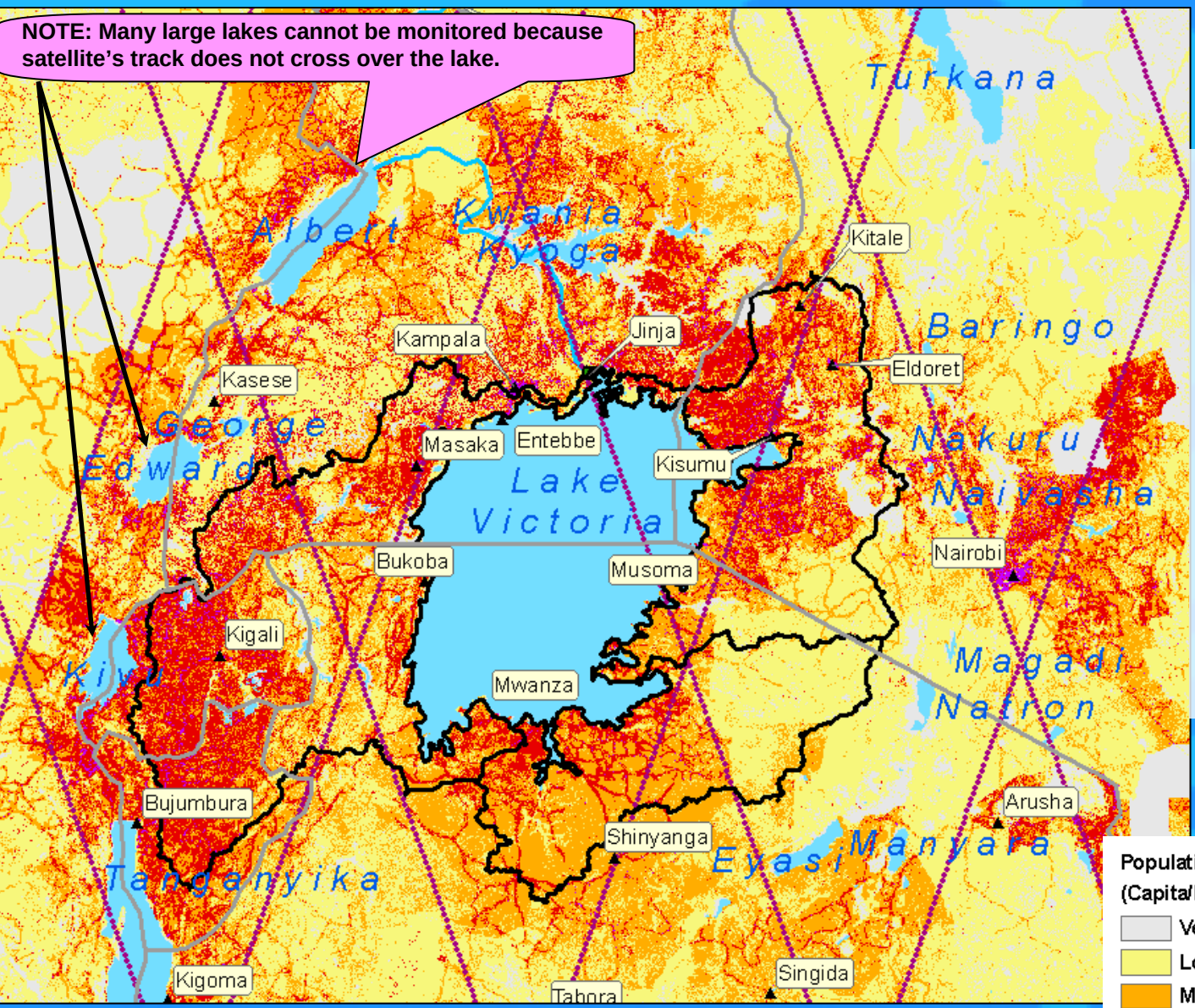
Contract # AG3151-C-06-0006 Foreign Agricultural Service
Prime: Arctic Slope Research Corporation Management Services (ASRC-MS).
Seven (7) Prime Vendors and Service Companies:
DIGITAL GLOBE, EOTEC, EURIMAGE, GEOEYE, MDA Federal, MDA Geospatial, SPOT

Requirements are for standing and ad-hoc orders based on price, product type, delivered times, and cloud-free criteria (< 50%) for global area of coverage. ASRC-MS negotiates the best price from the seven prime vendors based on these requirements to meet expected delivery times.

Not shown but available:
IKONOS
0.82m panchromatic
3.2m multispectral
11.3km image swath

QuickBird
61cm panchromatic
2.44m multispectral
16.5km image swath

High Population Density Surrounds Lake Victoria



- Lake Victoria is source of the White Nile.
- 30-million people live within Lake Victoria's river basin.
- Developing hydropower potential along Uganda's White Nile (and Ethiopia's Blue Nile) could help alleviate poverty for the Horn Africa.
- Lake resources must be monitored and sustainably managed.

Population Density (Capita/km2)
- Very Low (<1)
- Low (1-25)
- Medium (25-100)
- High (100-1000)
- Very High (>1000)

- Cities/towns
- Country Boundaries
- Owens Falls Dam
- Satellite Tracks
- Lake Victoria Basin
- Nile River
- Lakes

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