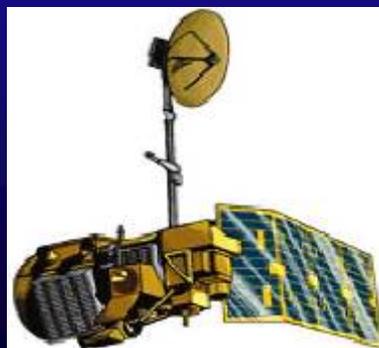


Interior's Role in Terrestrial Earth Observations

USGS Remarks for the 2008 JACIE Workshop, Fair Oaks, VA

Barbara J. Ryan
Associate Director for Geography
U.S. Geological Survey

U.S. Department of the Interior
U.S. Geological Survey



Overview

- **Historical Context**
- **Applications**
- **Landsat Updates**
- **Calibration Efforts**
- **The Way Forward**

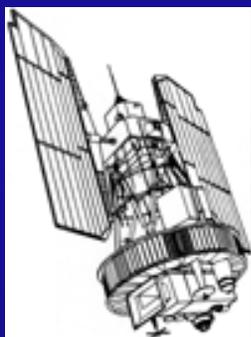


Satellite Remote Sensing at DOI

1966 - Initiated Earth Resources Observation Systems Program

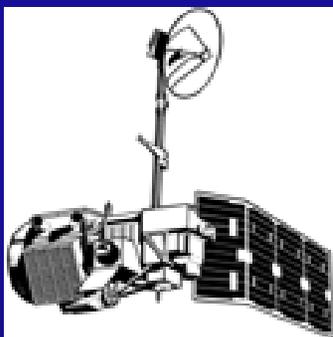
“...the time is now right and urgent to apply space technology towards the solution of many pressing natural resource problems being compounded by population and industrial growth.”

Secretary of the Interior Stewart L. Udall, 1966



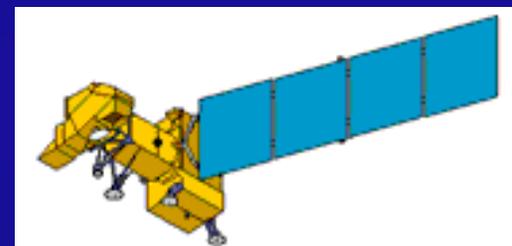
Landsat 1-3

Multi-Spectral Scanner (MSS) 79 meter
Return Beam Vidicon (RBV) 80/40 meter



Landsat 4-5

Multi-Spectral Scanner (MSS) 79 meter
Thematic Mapper (TM) 30 meter



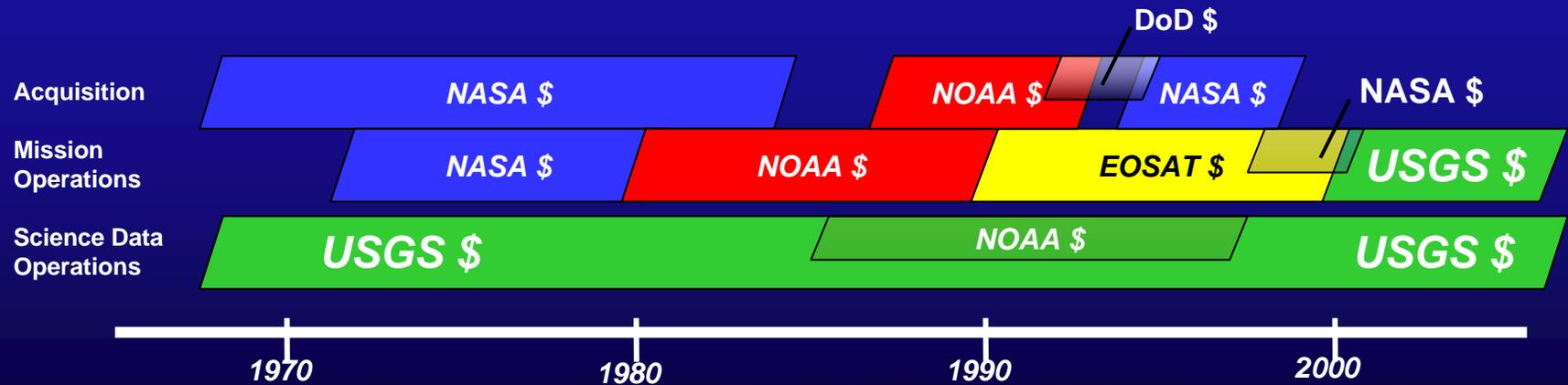
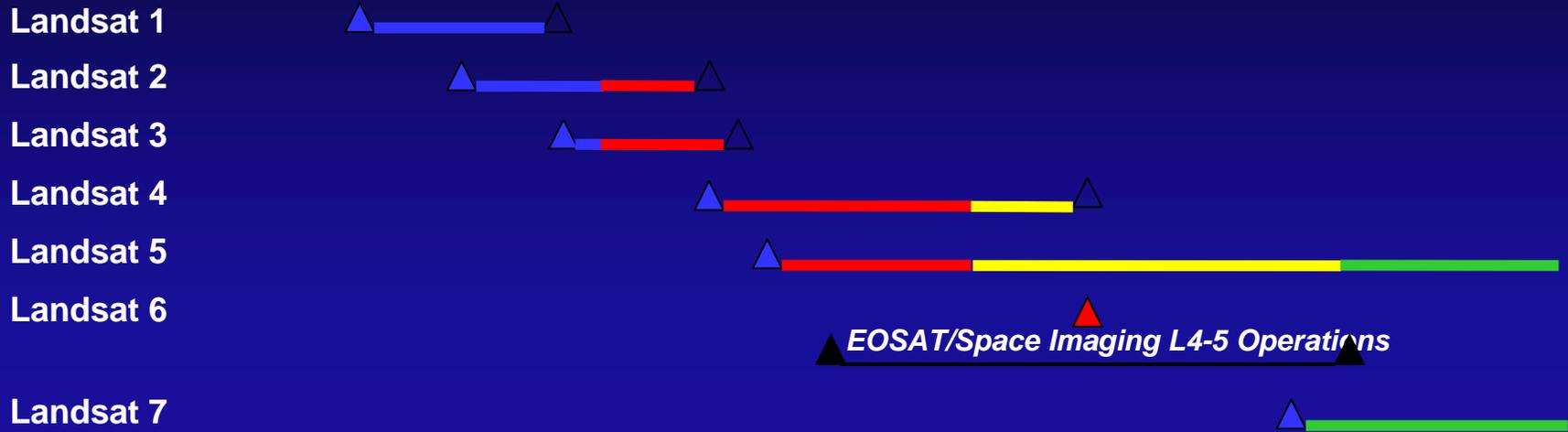
Landsat 7

Enhanced Thematic Mapper Plus (ETM+) 30/15 meter

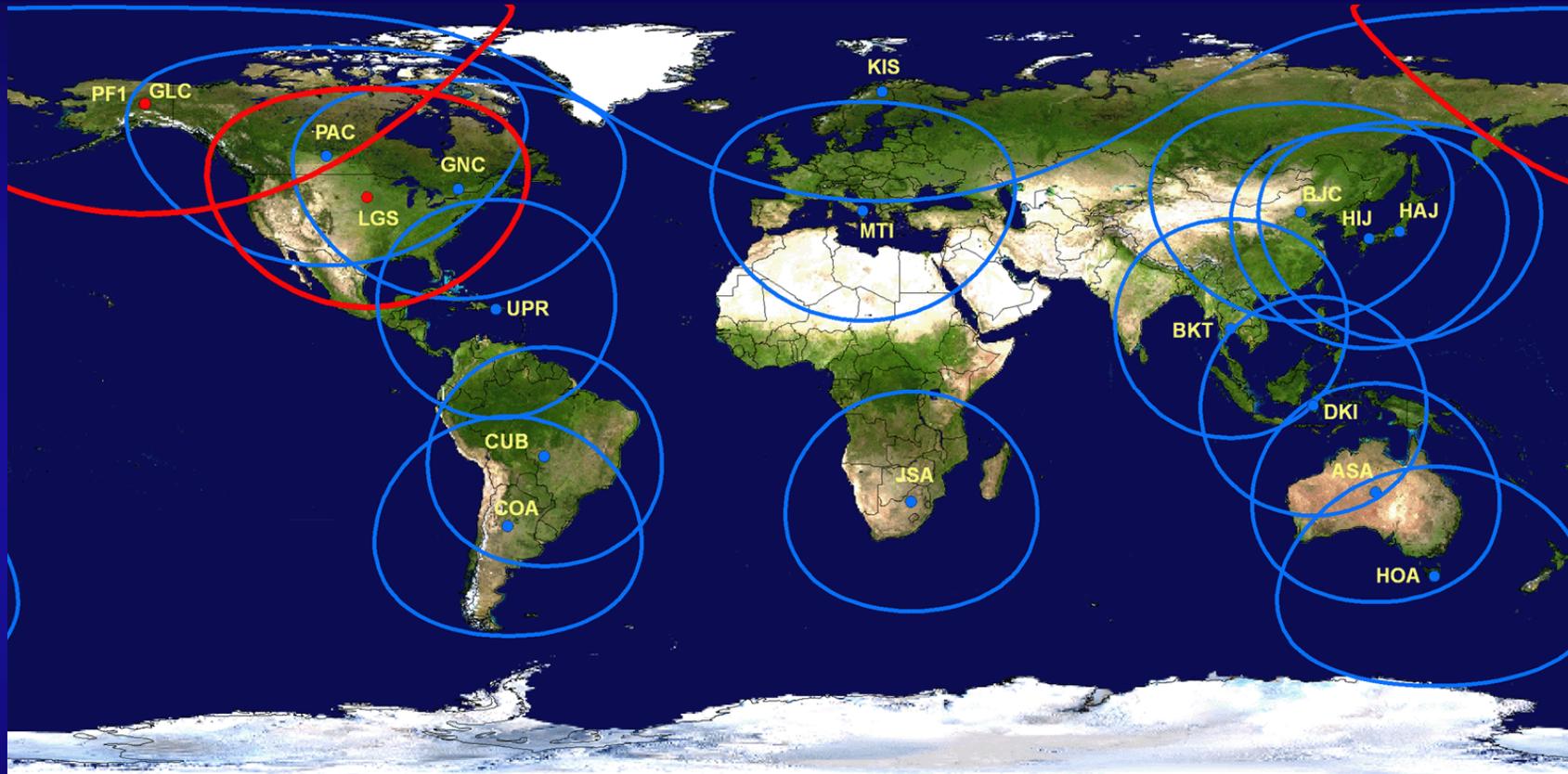
2005 – DOI Owns and Operates Landsats 5 & 7 and Archives Earth Observation Data from 6 Operational Satellites



Landsat Program and Funding History



International Partners – A Global Network



ASA: Alice Springs, Australia (L5/L7)

BJC: Beijing, China (L5)

BKT: Bangkok, Thailand (L5)

COA: Cordoba, Argentina (L5/L7)

CUB: Cuiaba, Brazil (L5)

DKI: Parepare, Indonesia (L7)

GLC: Gilmore Creek (L5)

GNC: Gatineau, Canada (L5)

HAI: Hatoyama, Japan (L5)

HIJ: Hiroshima, Japan (L7)

HOA: Hobart, Australia (L5/L7)

JSA: Johannesburg, South Africa (L5)

KIS: Kiruna, Sweden (L5)

LGS: Landsat Ground Station (L5/L7)

MTI: Matera, Italy (L5)

PAC: Prince Albert, Canada (L5)

PF1: Gilmore Creek (L5)

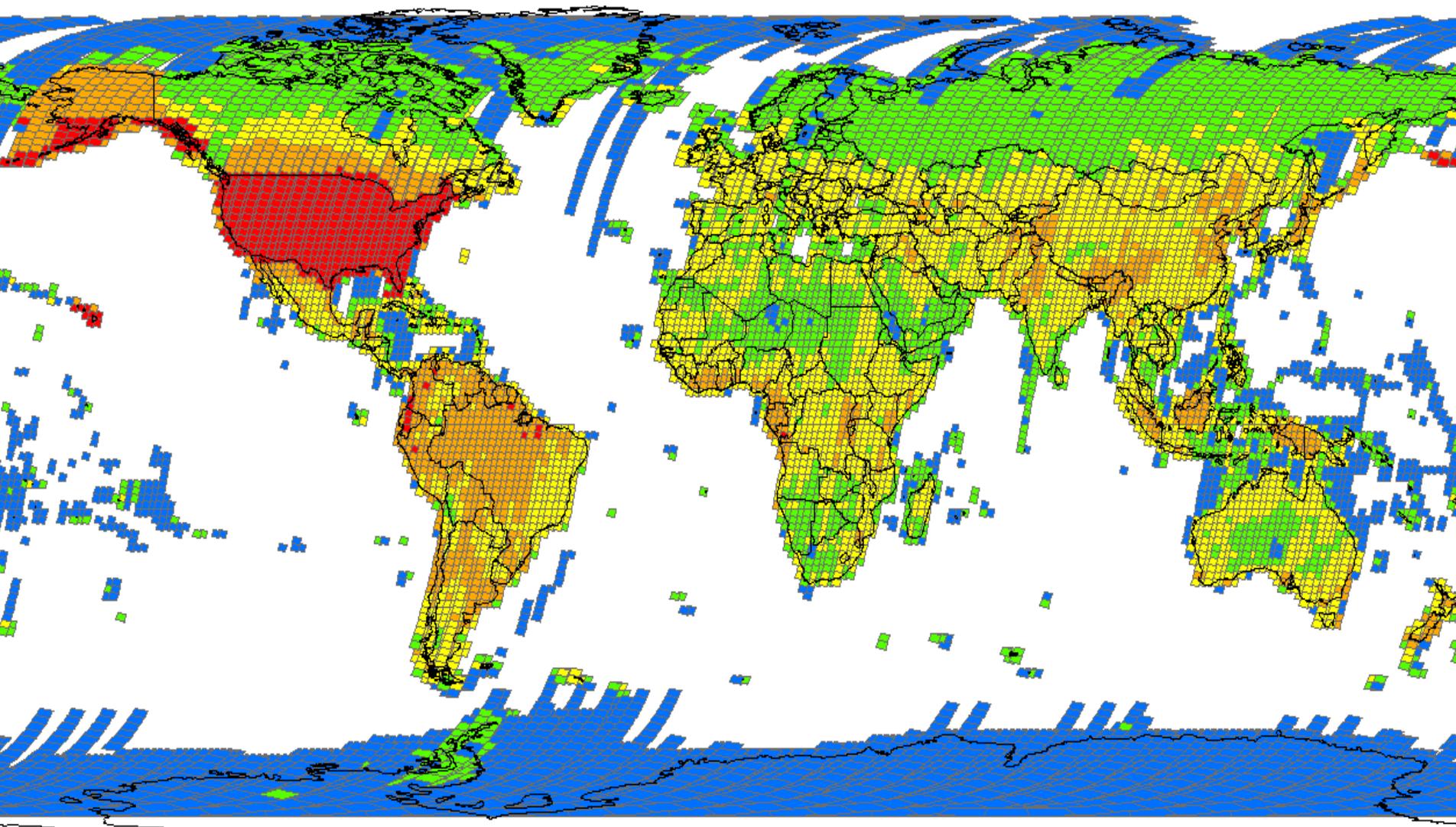
UPR: University of Puerto Rico (L7)

Landsat Collections

- Landsat 5 and its Thematic Mapper (TM) sensor have been on orbit for 22 years
- Landsat 7 and its Enhanced Thematic Mapper-Plus (ETM+) sensor have been on orbit for 7 years
- Over 300 Landsat 7 scenes (over 9 million square kilometers) obtained per day by USGS alone



Global U.S. Archive



Full scenes archived in LAM
29 June 1999 through 29 September 2004



DOI Applications of Landsat Imagery

Agriculture & Forestry

Crop and Timber Inventories, Crop Forecasting
Crop, Irrigation, & Forest Management

Wildlife & Public Lands

Vegetation, Species, Habitat & Wetlands Inventories & Management
Refuge Management & Planning
Natural Resource, Mineral Wealth, Rangeland Management

Commerce & Industry

Land & Property Valuation
Real Estate Property Management
Mines, Mineral Resources, & Energy Exploration & Management
Power Plant & Pipeline Management
Transportation Planning & Management
Inland Waterway, Open Sea, Sea Ice, & Port Navigation

Regional, State, and Local Government

Land Surveys, Soils & Geologic Mapping
Water Resource Planning, Reservoir & Water Quality Management
Land Use Planning
Real Property & Government Property Management
Spring Flooding Prediction & Analysis, Flood Plain Assessment
Erosion Control

Disaster Management

- Hazard Analysis
- Disaster Mitigation & Planning
- Damage Assessment
- Recovery & Relief

Hurricanes & Severe Storms
Floods & Landslides
Wildfires & Forest Fires
Earthquakes & Volcanoes

International Economic Development

National Security / Homeland Security

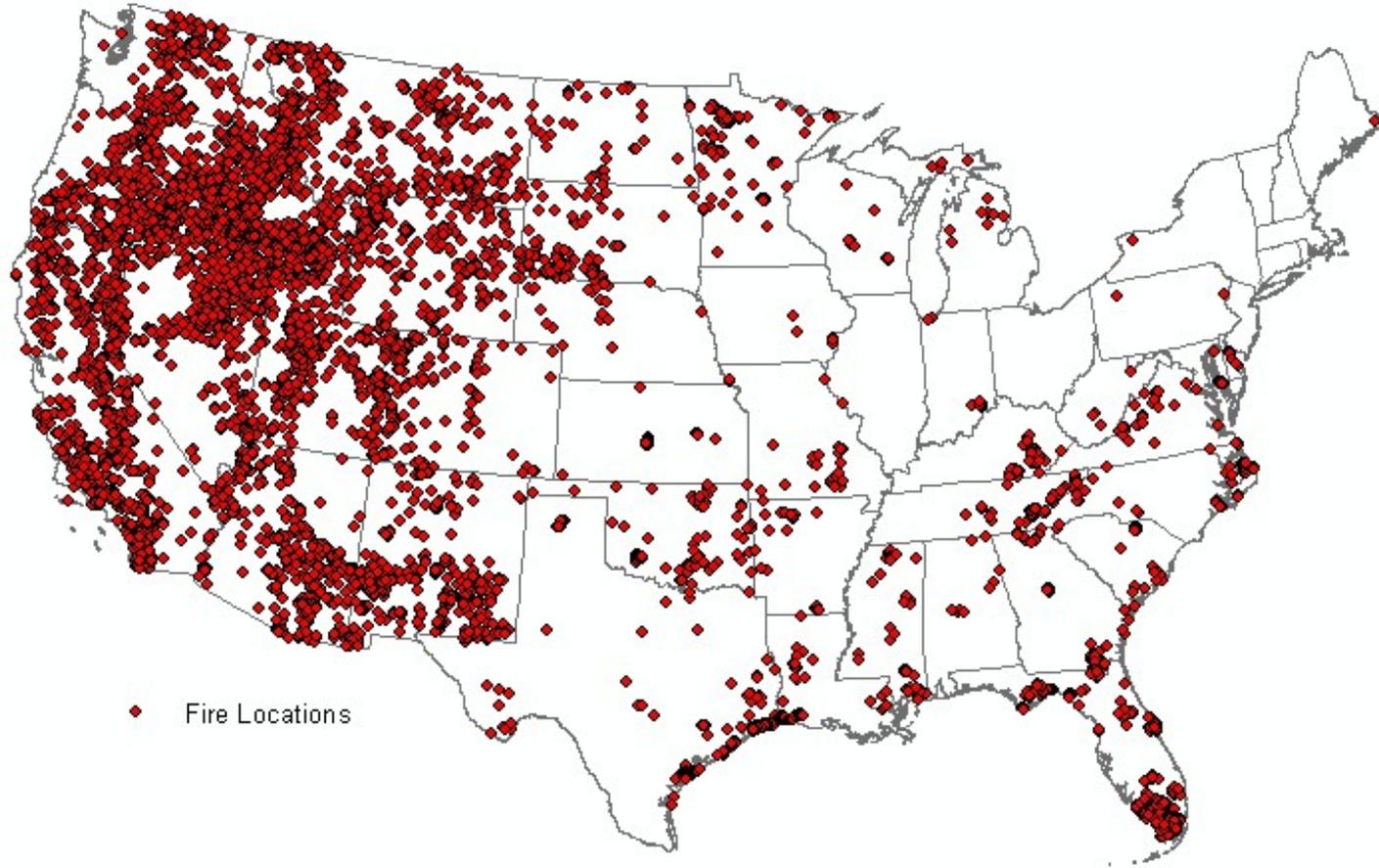
Global Change Policy & Research

Land Cover Change, Deforestation, Desertification, Salinization
Land Surface Processes, Hydrology, Snow cover & Glaciation
Ecosystem Analysis, Urban and Rural Geography



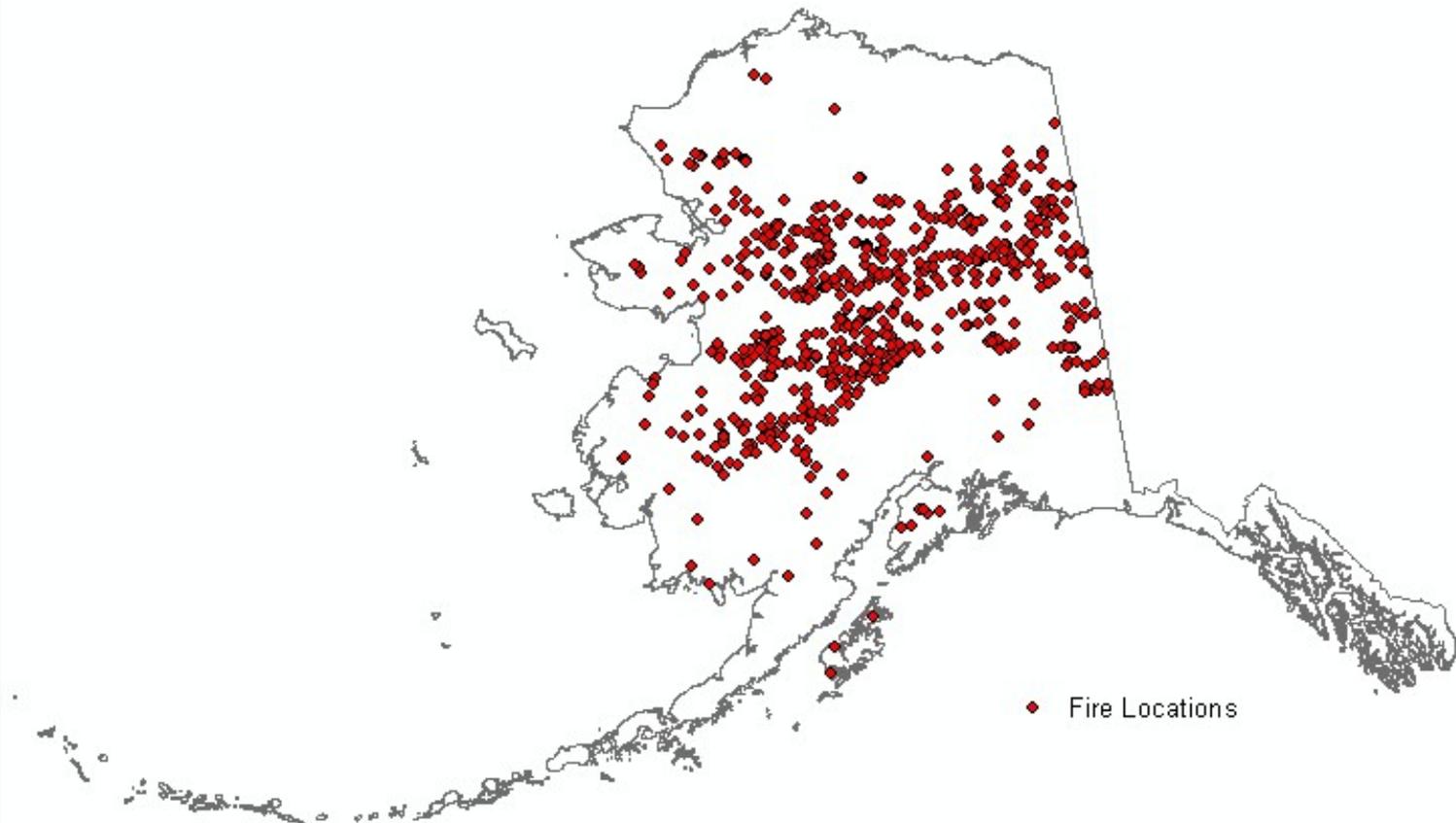
Locations of Large Wildland Fires

Fires greater than 1000 acres in Lower 48 (>500ac in East) since 1982
From BLM/Denver Database



Locations of Large Wildland Fires

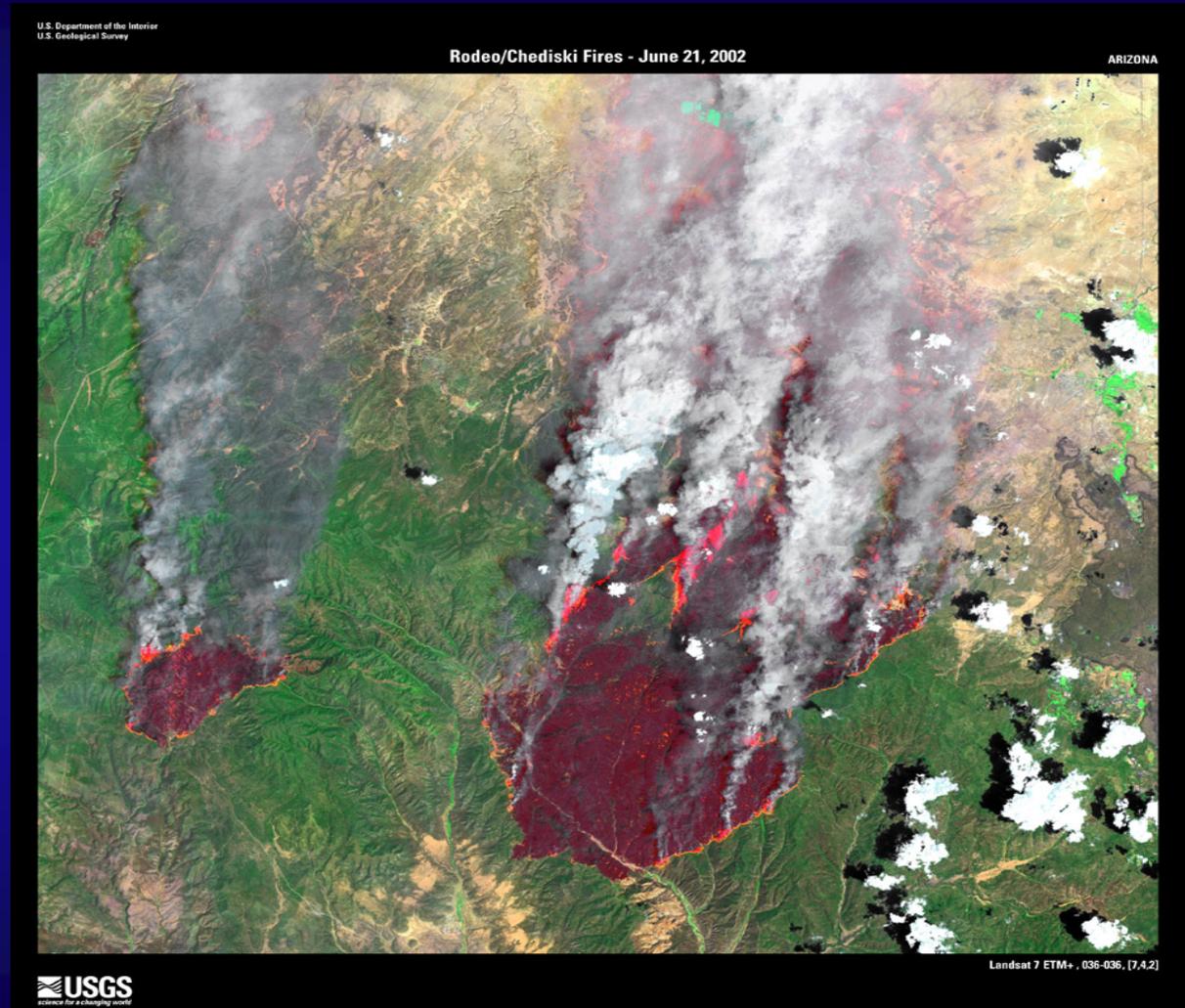
Alaska fires greater than 1000 acres since 1982
From BLM/Denver Database



Landsat 7 Image of Wildland Fires

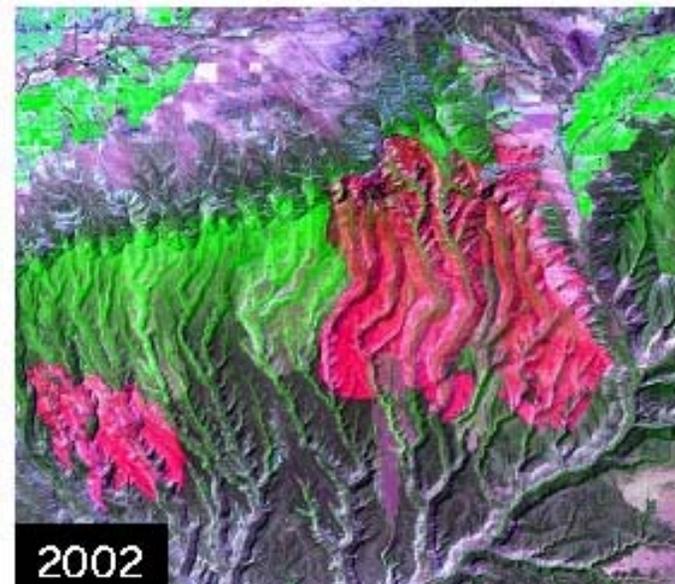
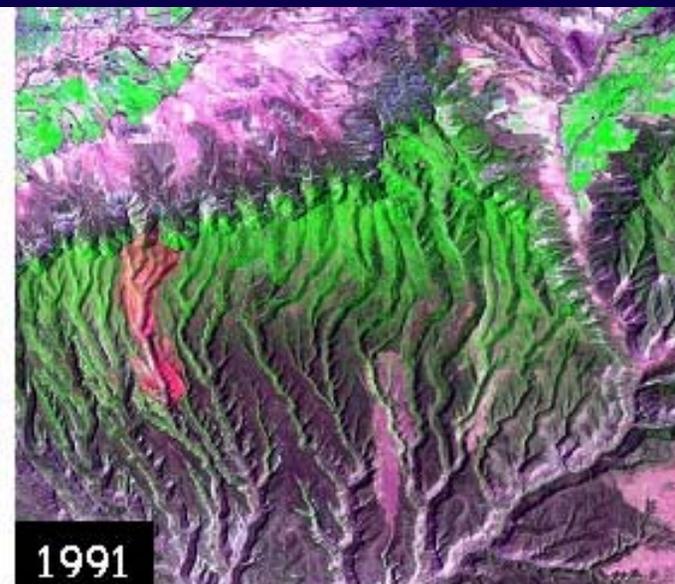
Rodeo Fire, AZ

- acquired 21 June 2002
- color infrared
- dark red is burn scar
- orange is active fire



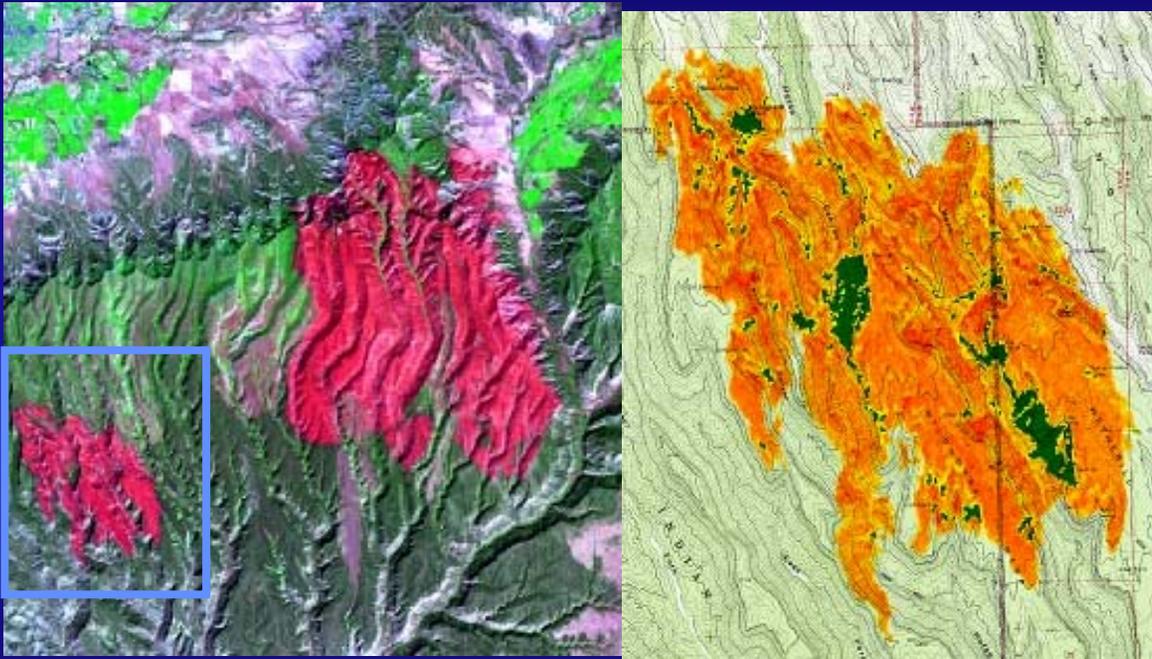
Wildfires -- Three Decades of Change

Mesa Verde
National Park,
Colorado



Wildfire: Quantifying the Damage

Mesa Verde National Park – Pony Fire, August 2000



Landsat 7 image showing fire scars

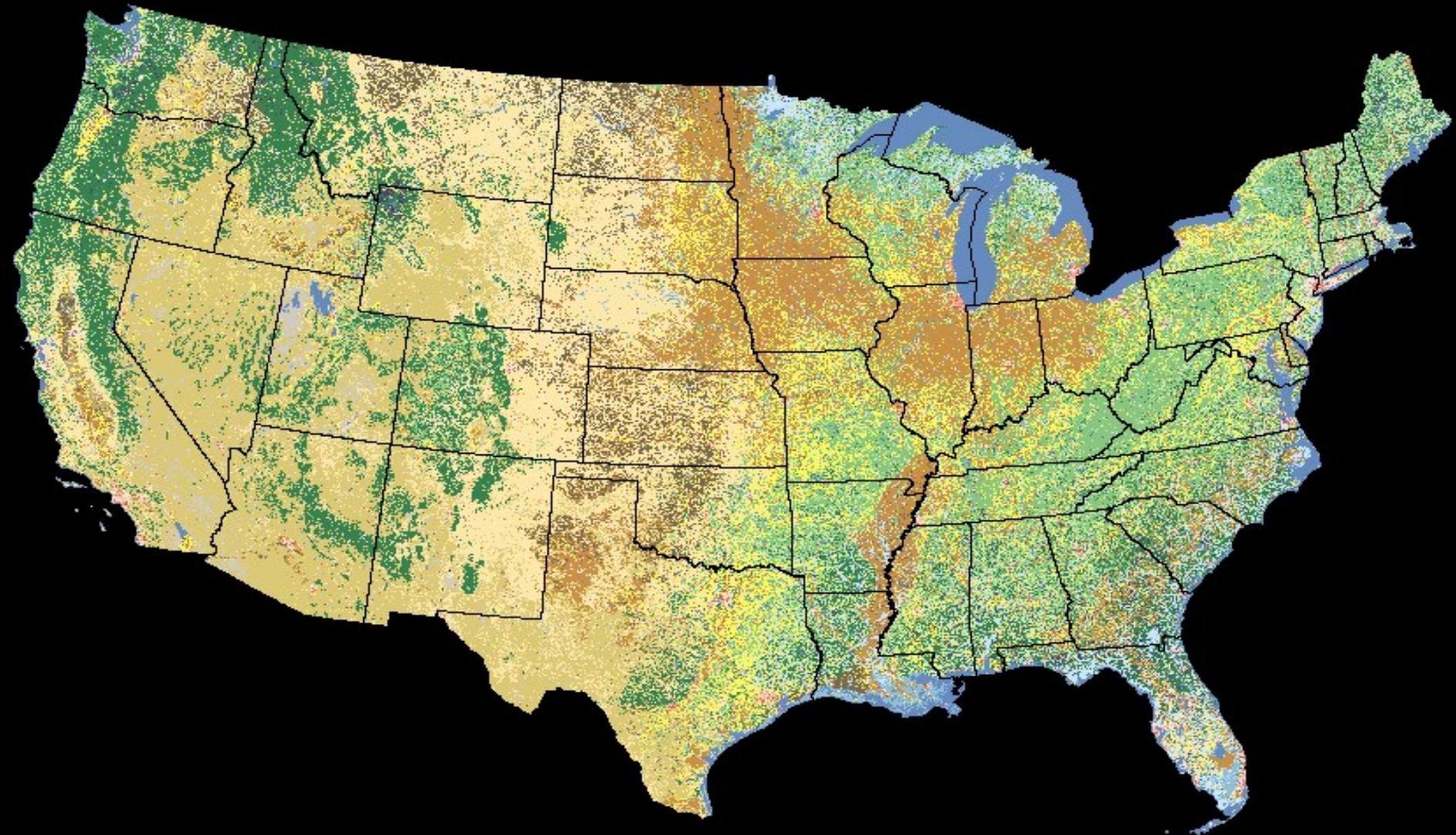
Burn Severity Index

Green- Unburned
Yellow- Moderate Burn
Orange- Severe Burn

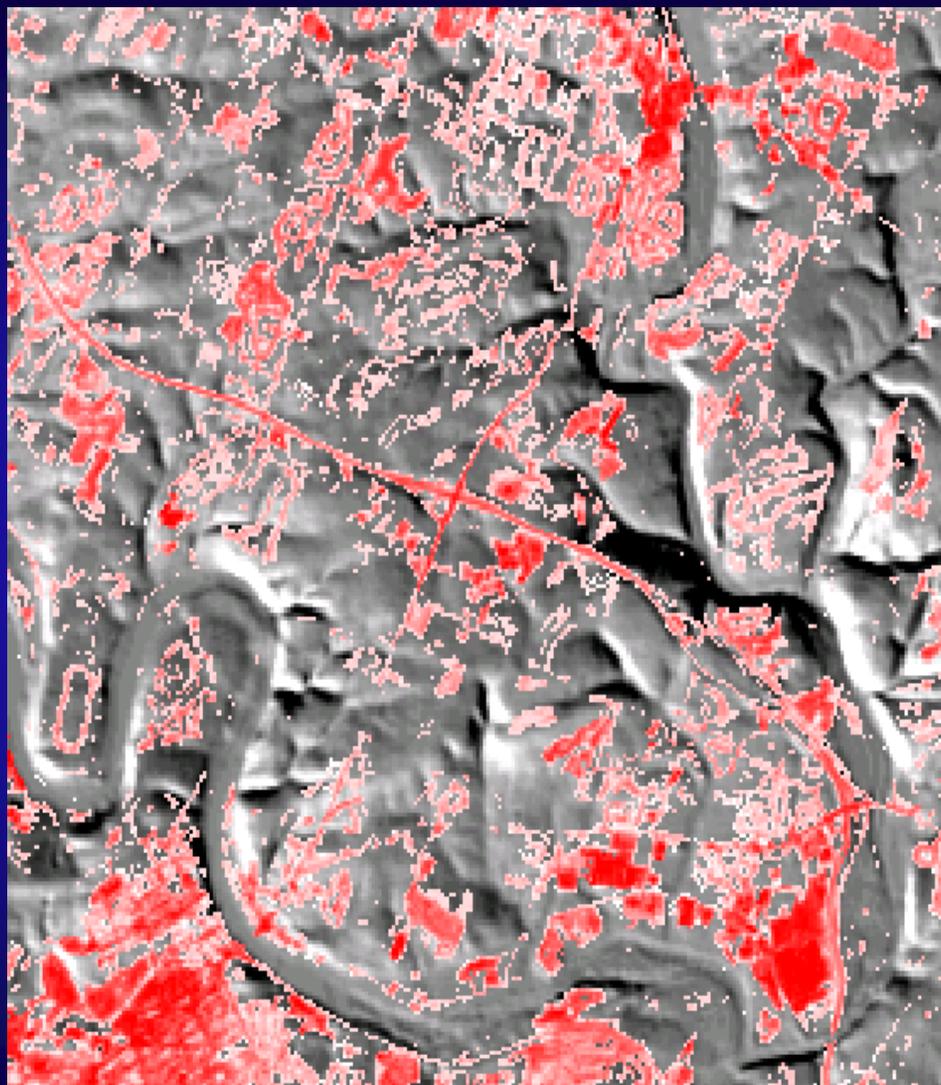
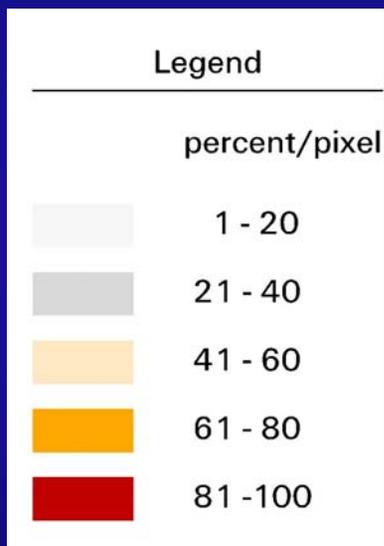
Partners

National Park Service
GEOMAC
NIFC
Joint Fire Science Program
Forest Service

National Land Cover Dataset (NLCD)



Impervious Surfaces



Selecting an Area for Query

The screenshot shows a web browser window titled "iSmart Web Runtime - Grids Demo - Microsoft Internet Explorer". The address bar contains the URL: `http://demo1.espatial.com/ismart/GridExample/ismw/mainMap2.jsp?ismw.zoomArea=nav&ismw.container=code_4557291&x1=93&y1=312&x2=243&y2=202`. The page features a USGS banner with the text "USGS science for a changing world" and a series of images depicting natural disasters. Below the banner is a map interface titled "iSmart Web Runtime - Grids Demo Map". The map displays a grid overlay on a landscape, with a red rectangle highlighting a specific area of interest. The interface includes a "Navigate" panel on the left with navigation tools, a "Layer Control" panel with checkboxes for "NLCD Data 1992", "NLCD Data 2001", "States", "Counties", "Census Blocks", and "NLCD Data Outline", and a "Draw Rectangle" panel with a "Draw Rectangle" button. A "Tool tips" section at the bottom left provides instructions: "Use the 'Navigate' control in the upper left to navigate around the map. Use the 'Layer' control underneath to switch on and off map layers. Use the 'Draw Rectangle' control to define an area of interest. These can later be used for grid analysis." The "POWERED BY espatial" logo is visible at the bottom right of the map area. The status bar at the bottom shows the current center point coordinates (1104907.9290639996, 1452421.5774950003), the projection system (Equal-Area Projection (United States)), and the time (7:14 AM). The taskbar at the bottom shows the Start button, several application icons, and the system tray.

Selecting a new Area For analyzing 2001 NCLD Coverage

The Result of the Query

USGS science for a changing world

ISmart Web Runtime - Grids Demo - Microsoft Internet Explorer

Address: http://demo1.espatial.com/ismart/GridExample/ismw/mainMap2.jsp?ismw.zoomArea=nav&ismw.container=code_4557291&x1=305&y1=343&x2=643&y2=92#

ISmart Web Runtime - Grids Demo Map

Layer Control

- NLCD Data 1992
- NLCD Data 2001
- States
- Counties
- Census Blocks
- NLCD Data Outline

Update Map

Draw Rectangle

Analyse [More Info](#)

View Source Code

Tool tips

- Use the 'Navigate' control in the upper left
- Use the 'Layer' control underneath to
- Use the 'Draw Rectangle' control to

Analysis Results - Microsoft Internet Explorer

<http://demo1.espatial.com> - Analysis Results - Microsoft Internet Explorer

Z57_1992NLCD

CellValue	Area (h)	%	Description
11	236.25	0.0	Open Water
21	6090.21	21.0	Developed, Open Space
22	969.21	3.0	Developed, Low Intensity
23	1806.12	6.0	Developed, Medium Intensity
31	86.22	0.0	Barren Land (Rock/Sand/Clay)
32	146.88	0.0	Unconsolidated Shore
41	6960.69	24.0	Deciduous Forest
42	4368.51	15.0	Evergreen Forest
43	4411.8	15.0	Mixed Forest
81	1814.4	6.0	Pasture/Hay
82	392.4	1.0	Cultivated Crops
85	824.85	2.0	Urban/Recreational Grasses
91	79.47	0.0	Palustrine Forested Wetland
92	8.91	0.0	Palustrine Scrub/Shrub Wetland

Done

Internet

Current Center Point: 1198091.9290639998, 1481605.5774950003 Projection System: Equal-Area Projection (United States)

Start | 6 Yahoo! Messenger | Inbox - Microsoft Outlook | ISmart Web Runtime - ... | <http://demo1.espatial.com> | NLCD_USGS | 7:11 AM

Center for Lidar Information Coordination and Knowledge - CLICK

CLICK is designed to facilitate innovation in the scientific community by providing a place for all LIDAR users—inside and outside the USGS—to visit, ask and answer questions, and coordinate with others who are seeking or have data in their study area.

<http://lidar.cr.usgs.gov>

The screenshot shows the USGS CLICK website. At the top left is the USGS logo with the tagline "science for a changing world". To the right is a navigation menu with "USGS Home", "Contact USGS", and "Search USGS". Below this is a green banner with the text "Welcome to the USGS Center for LIDAR Information Coordination and Knowledge". A secondary navigation bar contains "Bulletin Board", "Data Viewer", "Websites/References", and "Home". The main heading "CLICK" is centered. Below it, the "Mission:" section explains the increasing demand for lidar data and lists two challenges: high cost and a steep learning curve. A map of the United States is shown with the text "Find raw LIDAR" and various state abbreviations. A "NOTE:" section provides details about the data format and resolution. At the bottom, a "Featured Data" section displays three small map thumbnails labeled "Louisiana", "Lincoln, NE", and "North Carolina".

USGS
science for a changing world

USGS Home
Contact USGS
Search USGS

Welcome to the USGS Center for LIDAR Information Coordination and Knowledge

Bulletin Board Data Viewer Websites/References Home

CLICK

Mission:

There has been increasing demand for research utilizing all information generated from lidar remote sensing data and not just bare earth digital elevation models (DEMs). While this technology has been a proven mapping tool effective for generating bare earth DEMs, research on using the entire point cloud of this remote sensing data for scientific applications have been slowed by:

- The high cost of collecting lidar
- A steep learning curve on research and understanding involving utilizing the entire point cloud.

The goal of CLICK is to facilitate data access, user coordination and education of lidar remote sensing for scientific needs.

Find raw LIDAR

NOTE:
The CLICK viewer is for LIDAR XYZ point cloud downloads only. No processing or bare earth filtering has been performed. Datasets have been donated, and will have varying posting densities, file formats and accuracies. Use the query tool to determine each project's attributes. Data is delivered in USGS quarter-quad tiles in either LAS binary or ASCII text format, depending on the dataset. Check the download screen to determine file type. Bare earth grids at 10m are second resolution are part of the National Elevation Dataset, and can be found at <http://viewfinder.usgs.gov>

Featured Data

Louisiana Lincoln, NE North Carolina

Landsat Web-enabled Data Pilot

- June 2007 the USGS web-enabled Landsat 7 post-anomaly image data of the United States – including Alaska and Hawaii
 - 2003 to present
 - < 20% cloud cover
 - <http://glovis.usgs.gov/> or <http://earthexplorer.usgs.gov/>
- Recipe recommended by LST for the pilot project and for Global Land Survey dataset
 - Pixel size: 15m/30m/60m
 - Media type: Download (no cost), CD/DVD (\$50)
 - Product type: L1T (terrain-corrected)
 - Output format: GeoTIFF
 - Map projection: UTM
 - Orientation: North up
 - Resampling: Cubic convolution



Future plans for Landsat Data Availability

- **FY08**
 - **Expand to include all Landsat 7 post-anomaly data**
 - **Continue additions to include Multi-Resolution Land Characteristics (MRLC) dataset**
- **FY09**
 - **Complete and provide Global Land Survey (GLS) 2005 dataset**
 - **Provide Landsat 7 pre-anomaly data**
 - **Provide Landsat 4/5 TM data**
 - **Provide Landsat MSS data**



Landsat 7 Status

- L7 and its Enhanced Thematic Mapper-Plus (ETM+) sensor have been operating on orbit for 9 years; five year design life
 - ETM+ scan line corrector (SLC) failed May 2003;
 - 1 of 3 gyros turned off May 2004; USGS developing 1-gyro flight capability
 - Other subsystems still operating nominally
 - L7 transitioned to bumper mode in April 2007; calibration adjusted
 - Full US and seasonal global coverage continues for long-term archive
 - Current fuel model may allow 2011 cross calibration, assuming all other systems remaining healthy



Landsat 5 Status

- L5 and its Thematic Mapper (TM) sensor have been operating on orbit for 25 years; three year design life
 - Large fuel tank was designed to lower orbit for Shuttle retrieval
 - No onboard data recorder – US and 9 International Cooperators (12 ground stations) capture TM data
 - Some critical subsystems running on back-up components (X-band amplifier)
 - Solar array drive malfunctioned in November 2005; operations changed in 2006 to fixed-array mode
 - Battery 2 power reduction in Oct 2007; Reduced US and Global coverage
 - Current fuel model may allow 2011 cross calibration, assuming all other systems remaining healthy



Landsat Data Continuity Mission (LDCM) – Landsat 8

- **USGS NASA Partnership**
 - NASA - satellite, instrument, launch
 - USGS- Ground Stations, Operations, Science Team
- **Projected launch July 2011 (ambitious schedule)**
- **Data policy**
 - Unrestricted, timely delivery of data
 - Preprocessed, orthorectified (terrain-corrected) imagery
 - Value-added services provided by the commercial sector

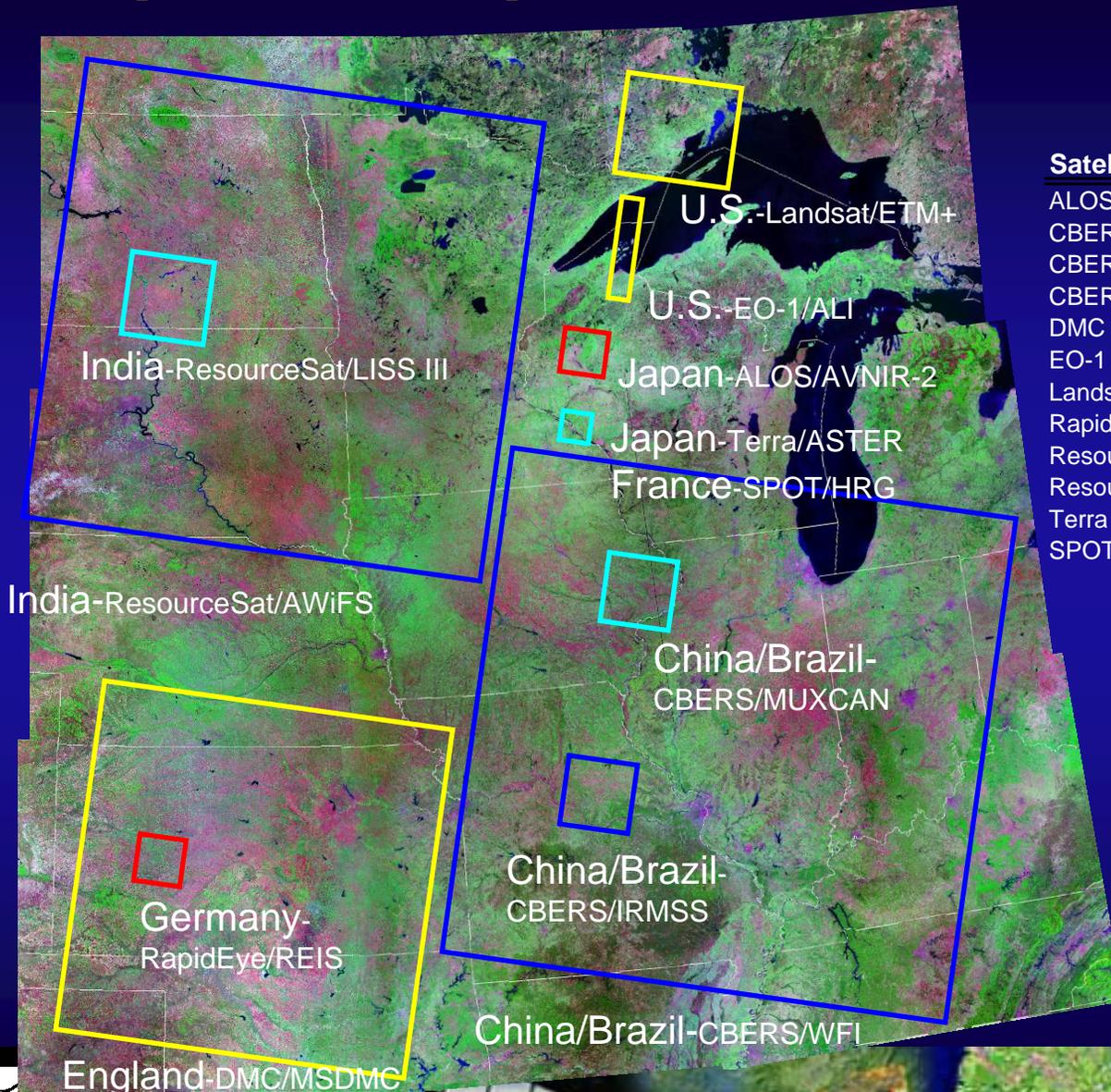


Current Project Status Operational Land Imager (OLI)

- Jan 2007 - NASA released RFP for an OLI
- Proposals were received Feb 2007
- OLI Contract Awarded to Ball Aerospace in July 2007
- Since Contract Award
 - Numerous subsystem peer reviews have been conducted
 - Completed successful Instrument Systems Requirements Review
 - Completed successful Instrument Integrated Baseline Review
 - Flight optics, filters, detectors, and optical bench in various phases of design and production
- On-going Requirements Optimization Exercise
 - Maximize probability of maintaining 39 month OLI development schedule



Footprint Comparisons

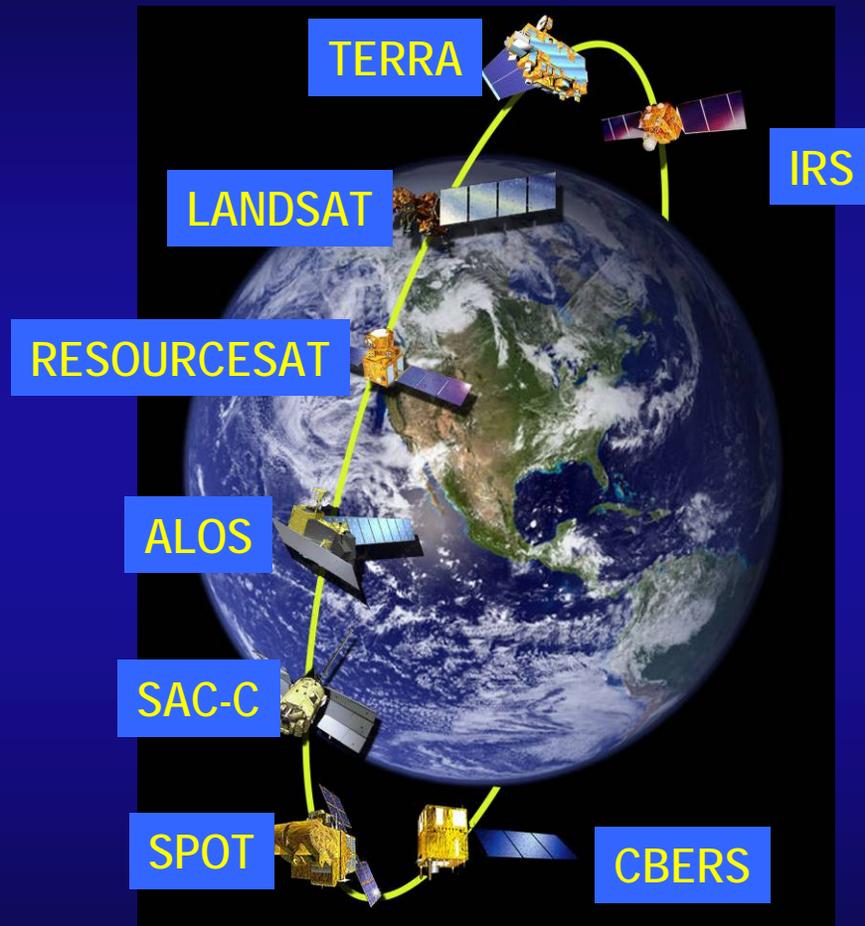


Satellite	Sensor	Ground sampling distance (m)	Swath width (km)
ALOS	AVNIR-2	10	70
CBERS-3,4	IRMSS	40/80	120
CBERS-3,4	MUXCAN	20	120
CBERS-3,4	WFI	73	866
DMC	MSDMC	32	600
EO-1	ALI	30	37
Landsat	ETM+	30	185
Rapideye	REIS	6.5	78
ResourceSat	LISS-III	23.5	141
ResourceSat	AWiFS	56	740
Terra	ASTER	15/30/90	60
SPOT	HRG	10/20	60

Note: For purposes of scene size comparison only; not actual orbital paths or operational acquisitions. High-resolution scenes too small to illustrate here.

Land Surface Imaging Constellation

- Formal Agreement among CEOS agencies, to formally coordinate operation of assets with goals to:
 - Harmonize data policy
 - Coordinate ground system assets
 - Provide coordinated acquisition and data management.
- Create a suite of constellation standards for moderate-resolution land surface imaging that can guide development of future systems.
- Provide data for development of a key Climate Data Record.
- Provide potential recommendations & guidelines to GEO for GEOSS policy.



JACIE-type Characterization Activities

- Provides an NLIP and GEOSS baseline for dataset interoperability to support integrated science
 - USGS is maintaining a web site of World-wide Calibration Test Sites for the GEO Cal Val portal
 - The JACIE process provides an independent evaluation process for all sensors
 - This mechanism provides continued support of Landsat system and temporal coverage data gaps
 - USGS is also developing complementary high resolution satellite and aerial sensor characterization ranges in the U.S.
 - More information available via USGS Remote Sensing Technologies Project - <http://calval.cr.usgs.gov/>





USGS Home
Contact USGS
Search USGS

The USGS Remote Sensing Technologies Project

Enter text:

Google™ CUIR01 54W02

Search RST

Home About Us Aerial Satellite Instrumentation Collaborations Resources Contact Us

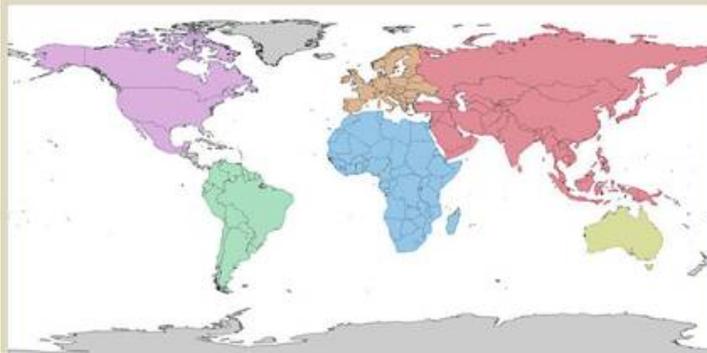
Remote Sensing Technologies - Satellite

Test Site Catalog

Catalog of World-wide Test Sites for Sensor Characterization

In an era when the number of Earth-observing satellites is rapidly growing and measurements from these sensors are used to answer increasingly urgent global issues, it is imperative that scientists and decision-makers rely on the accuracy of Earth-observing data products. The characterization and calibration of these sensors are vital to achieve an integrated Global Earth Observation System of Systems (GEOSS) for coordinated and sustained observations of Earth. The U.S. Geological Survey (USGS), as a supporting member of Committee on Earth Observation Satellites (CEOS) and GEOSS, worked with partners around the world to establish an online Catalog of prime candidate world-wide test sites for the post-launch characterization and calibration of space-based optical imaging sensors. The online Catalog provides easy public web site access to this vital information for the global community. Through greater access to and understanding of these vital test sites and their use, the validity and utility of information gained from Earth remote sensing will continue to improve. ([Additional Information](#))

Contact Information: Gyanesh Chander gchander@usgs.gov or Gregory L. Stensaas gstensaas@usgs.gov



Choose A Radiometric Site ▾

Choose A Geometry Site ▾

[Home](#)

[Radiometry Sites](#)

[Geometry Sites](#)

[Acronyms](#)

[References](#)

Accessibility FOIA Privacy Policies and Notices

U.S. Department of the Interior | U.S. Geological Survey

URL: <http://calval.cr.usgs.gov/>

Page Contact Information: erosweb@usgs.gov

Page Last Modified: Nov 8, 2007



Landsat Cross-Calibration Activities

- Recently completed or continuing
 - L7 ETM+ and L5 TM sensor
 - L5 TM and L4 TM sensor
 - L7 ETM+/L5 TM and EO-1 ALI sensor
 - L7 ETM+/L5 TM and Terra MODIS sensor
 - L7 ETM+/L5 TM and IRS-P6 AWiFS/LISS-III sensor
 - L7 ETM+/L5 TM and CBERS-2A CCD sensor
 - L7 ETM+/L5 TM and ALOS AVNIR-2 sensor
- On-going or planned with L7 and L5
 - Beijing1, CBERS-2B, DMC, THEOS, ResourceSat, RapidEye, SPOT
 - QuickBird, Worldview, GEOEYE, Topsat
 - AVHRR MetOP, ENVISAT MERIS, MODIS
 - ASTER DEM, Cartosat-1 and -2



USGS Digital Ortho-Photo and Elevation Programs

- Data ingest, archive, and distribution for *The National Map*
 - National partnerships – Federal, State, Local
 - Seamless archive interface
- National Digital Elevation Dataset
 - National Digital Elevation Program
 - New USGS ASTER DEM global product being developed
 - USGS National LiDAR group - <http://lidar.cr.usgs.gov>
- Emergency response and hazards support
- USGS Quality Assurance Plan for Digital Aerial Imagery
 - QA guidelines and standards



USGS Plan for Quality Assurance of Digital Aerial Imagery

- Acquisition Guidelines and Specifications
- Manufacturer Certification
- Data Provider Certification
- Quality Assurance Guidelines (Product Delivery evaluation standards)
- Support and Training
- IADIWG: Inter-Agency Digital Imaging Working Group
 - Cooperating agencies: BOR, BLM, COE, DOT, EPA, FSA, FWS, NASA, NIST, NGA, NOAA, NRCS, USFS, and USGS
- USGS Plan approved and supported by IADIWG
 - Govt. and Industry support via workshops and conferences



Commercial Data and Acquisition Management

- [USGS Commercial Remote Sensing Space Policy \(CRSSP\)](#)
 - <http://crssp.usgs.gov/>
- [CRSSP Imagery-Derived Requirements \(CIDR\) Entry Tool](#)
 - <http://cidr.cr.usgs.gov/>
- [USGS Commercial Data Purchases \(UCDP\) Imagery Collection](#)
 - <http://edc.usgs.gov/products/satellite/ucdp.html>
- [USGS Commercial Remote Sensing Data Contracts \(CRSDC\)](#)
 - <http://geodatacontracts.er.usgs.gov/crsdc/index.html>



National Land Imaging Program

A PLAN FOR A U.S. NATIONAL LAND IMAGING PROGRAM



Future of Land Imaging
Interagency
Working Group

- In December 2005, the President's Science Advisor stated: "It remains the goal of the U.S. Government to transition the Landsat program from a series of independently planned missions to a sustained operational program..."
- In 2007, The Department of Interior accepted the role of leading the National Land Imaging Program (NLIP)



DOI Secretary Kempthorne @ GEO Summit



“And under US GEO leadership, this year the United States committed itself to continuing to provide Landsat-type imagery of the globe for the benefit of the US and the world.”

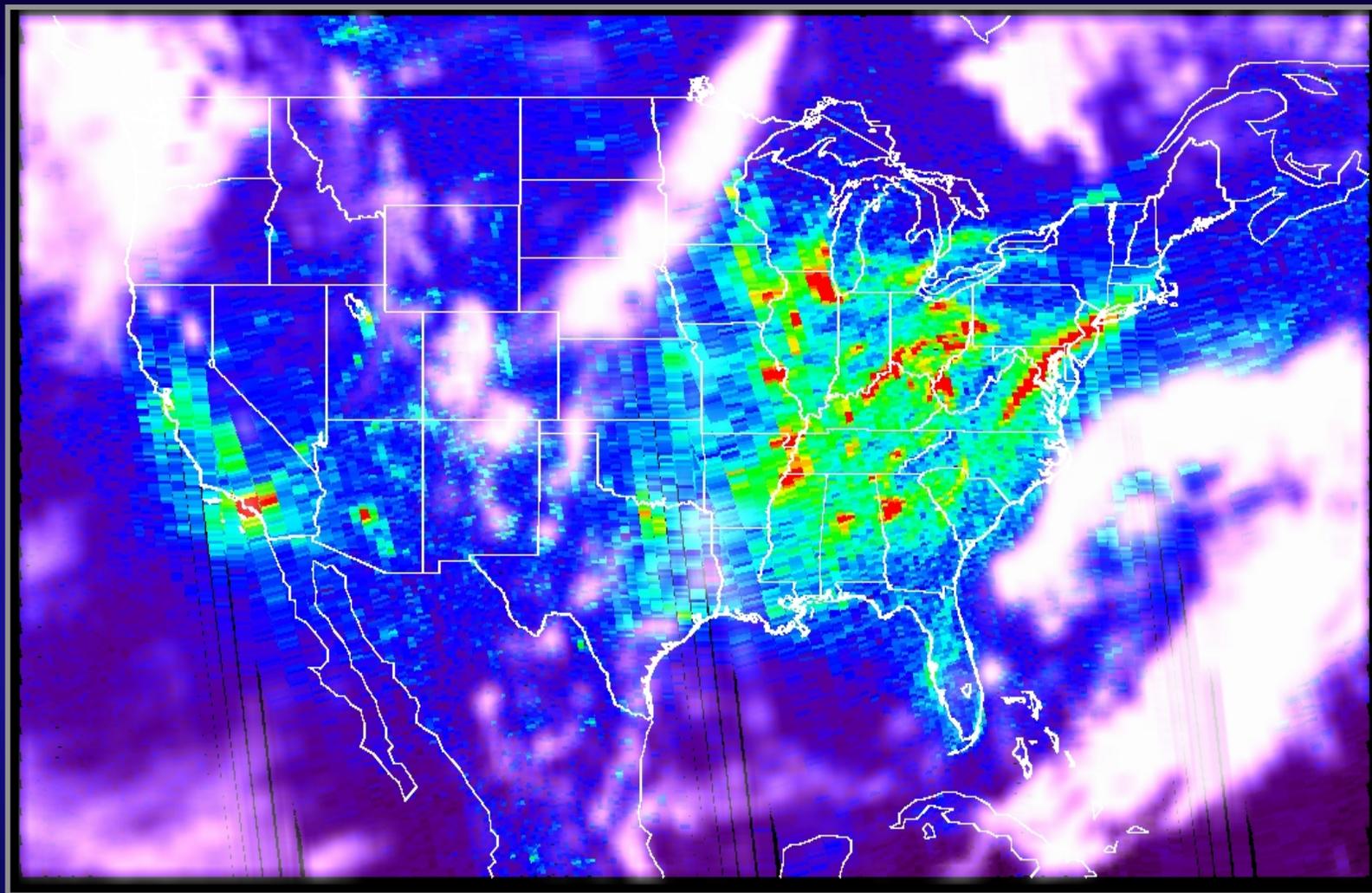
“If we are to make real advances in each of the social benefit areas of GEO we must share data, information and knowledge across national, cultural and language barriers. We must achieve global data compatibility. We must embrace the idea of science without borders.”



“The United States reaffirms its commitment to the Group on Earth Observations. We are committed to the advancement of Earth observation to address global economic, environmental and social issues.”



NO₂ Images for April 15, 2004



NASA

 USGS



Working across the Constellations -- Mt. Etna InSAR



Summary

- **Historical Context**
- **Applications**
- **Landsat Updates**
- **Calibration Efforts**
- **The Way Forward**

