Climate and Land Use Change
Earth Resources Observation and Science (EROS) Center

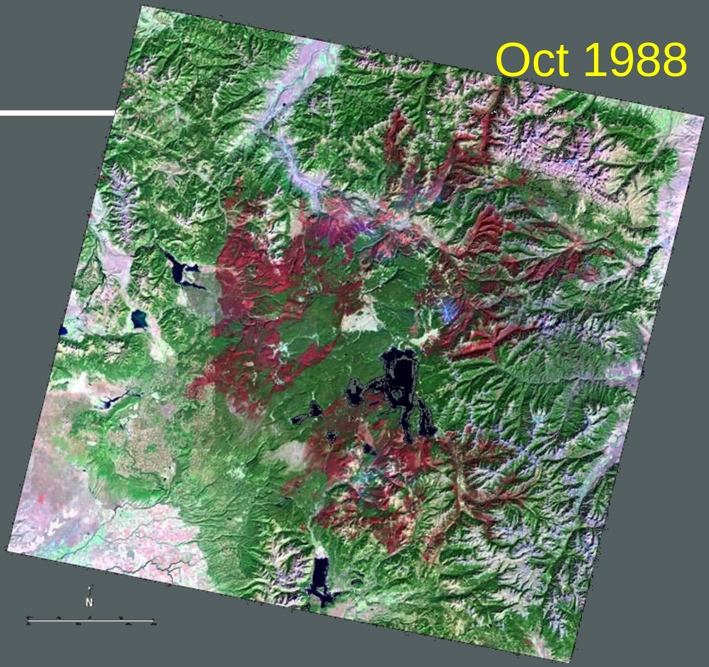
The Landsat Legacy: Monitoring a Changing Earth

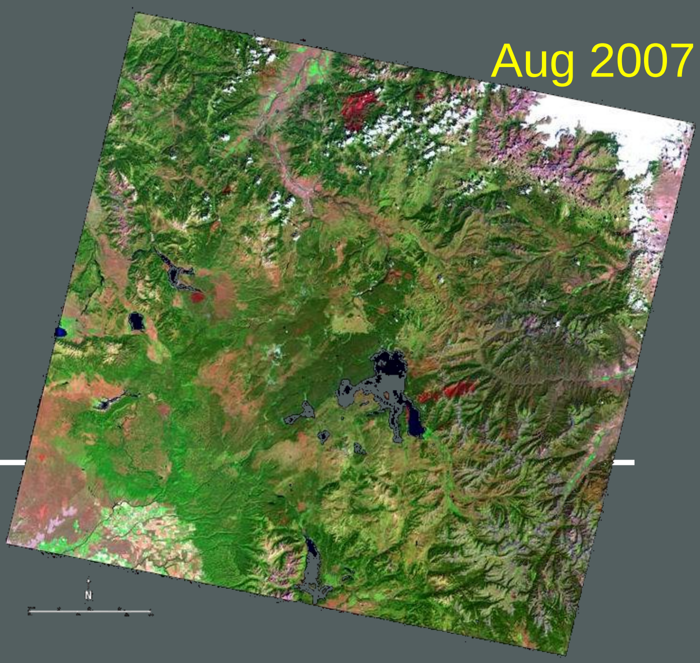
U.S. Department of the Interior
U.S. Geological Survey

Tom Loveland
March 17, 2001

Landsat Science Mission

- Change is occurring at rates unprecedented in human history
- The Landsat program provides the only inventory of the global land surface over time -
  - At a scale where human vs. natural causes of change can be differentiated
  - And on a seasonal basis
- No other satellite system is capable/committed to even annual global coverage at this scale

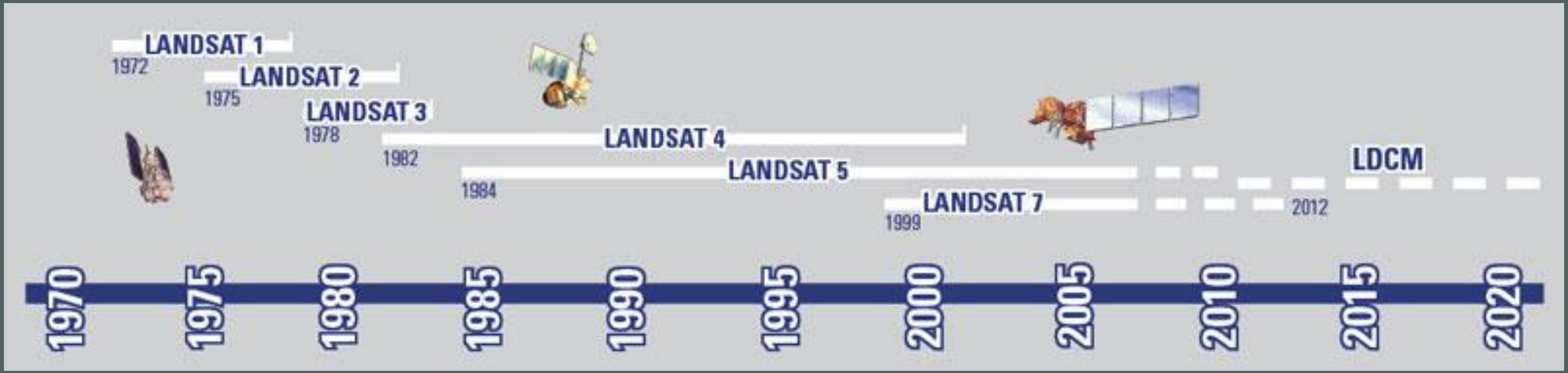




USGS

38+ Years of Continuous Landsat Global Land Observation

- Landsat 1 was launched July 23, 1972 (MSS)
- Landsat 2 was launched January 22, 1975 (MSS)
- Landsat 3 was launched March 5, 1978 (MSS)
- Landsat 4 was launched July 16, 1982 (TM)
- Landsat 5 was launched March 1, 1984 (TM)
- Landsat 6 was launched October 5, 1993, but never reached orbit
- Landsat 7 was launched April 15, 1999, May 2003 SLC-Off (ETM+)
- LDCM (Landsat 8) is scheduled for launched in December 2012

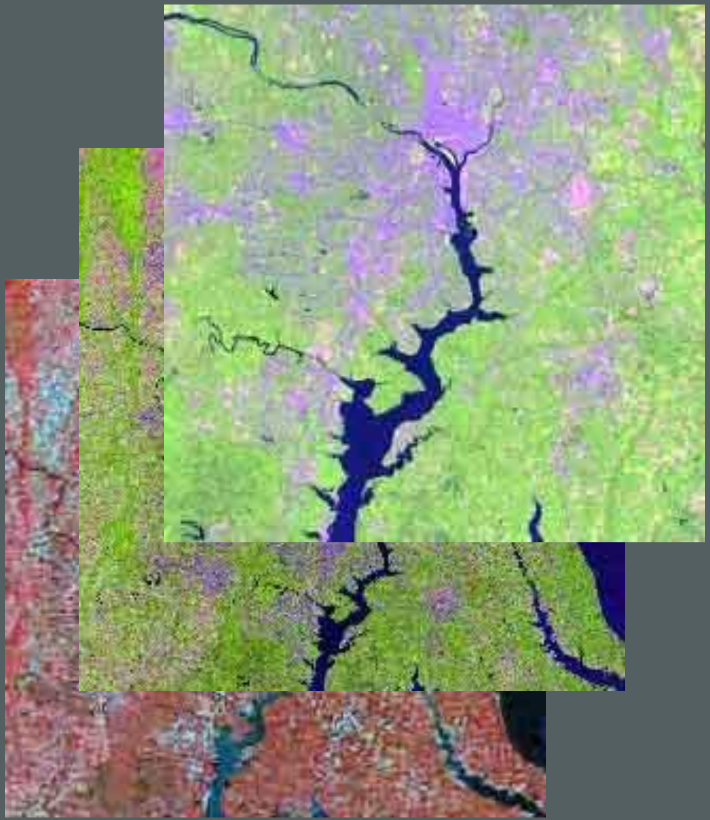


USGS

U.S. Landsat Archive Overview

(February 1, 2011)

- **ETM+: Landsat 7**
  - 1,114,722 scenes available
    - ~1,034 TB Raw and L0Ra Data
    - Archive grows by ~260 GB Daily
- **TM: Landsat 4 & Landsat 5**
  - 995,232 scenes available
    - ~498 TB Raw and L0Ra Data
    - Archive grows by ~ 80 GB Daily
- **MSS: Landsat 1 through 5**
  - 615,743 scenes available
    - ~18 TB Raw and L0Ra Data



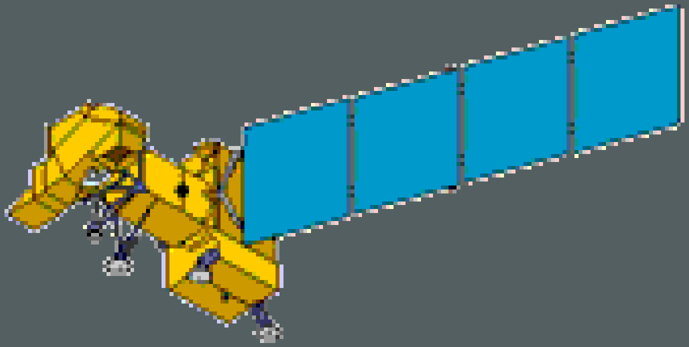
All US-held Landsat data are calibrated to a common radiometric standard.

USGS

Landsat 5 and 7 are still collecting data…

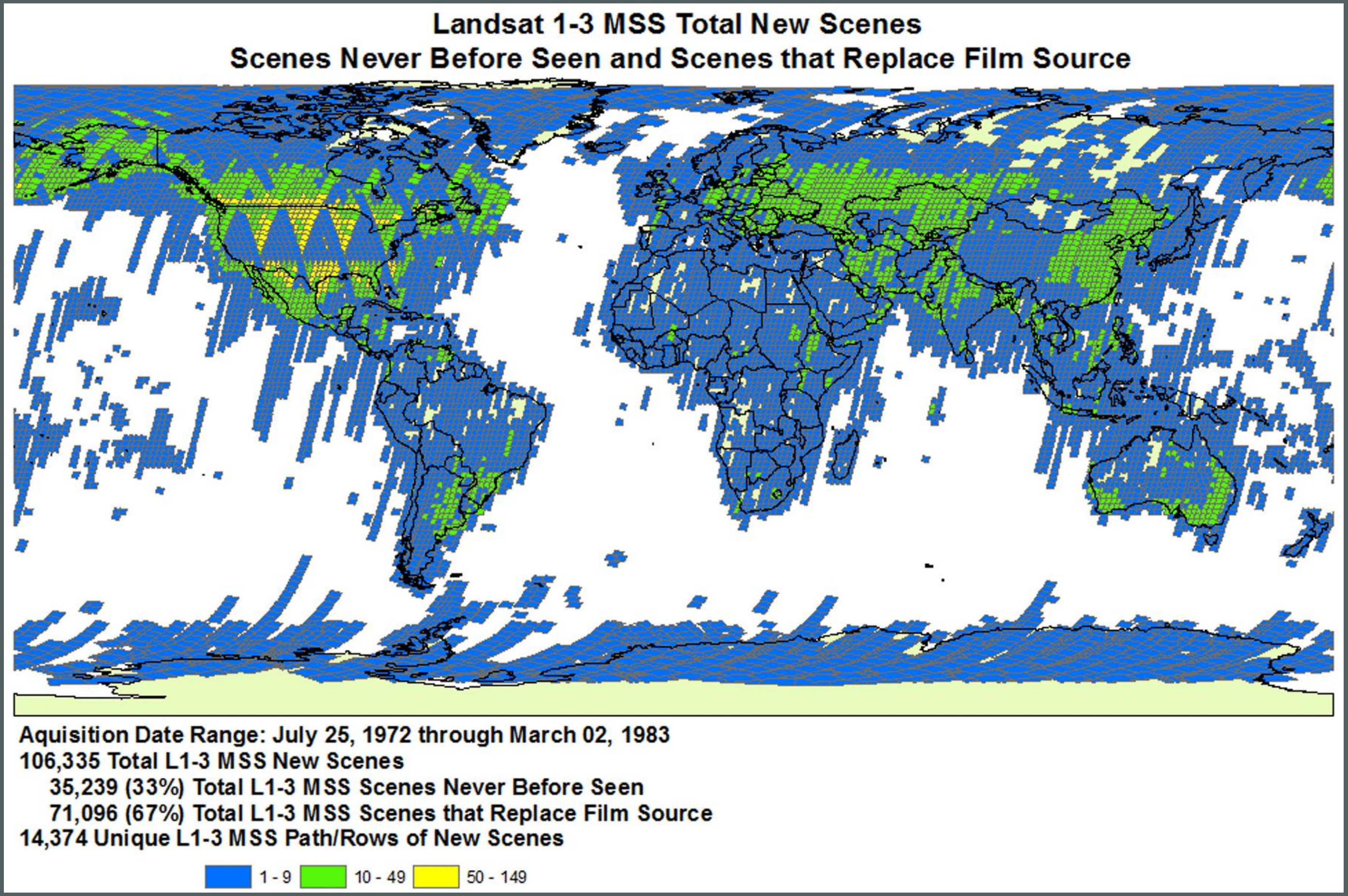
- Landsat 5 - 26 years since launch
  - 1984 Launch
  - TM - functioning normally
  - Limited global acquisitions
  - Precarious situation due to age

- Landsat 7 – nearly 12 years since launch
  - 1999 Launch
  - Robust global acquisitions
  - ETM+ - Scan Line Corrector Failure



USGS

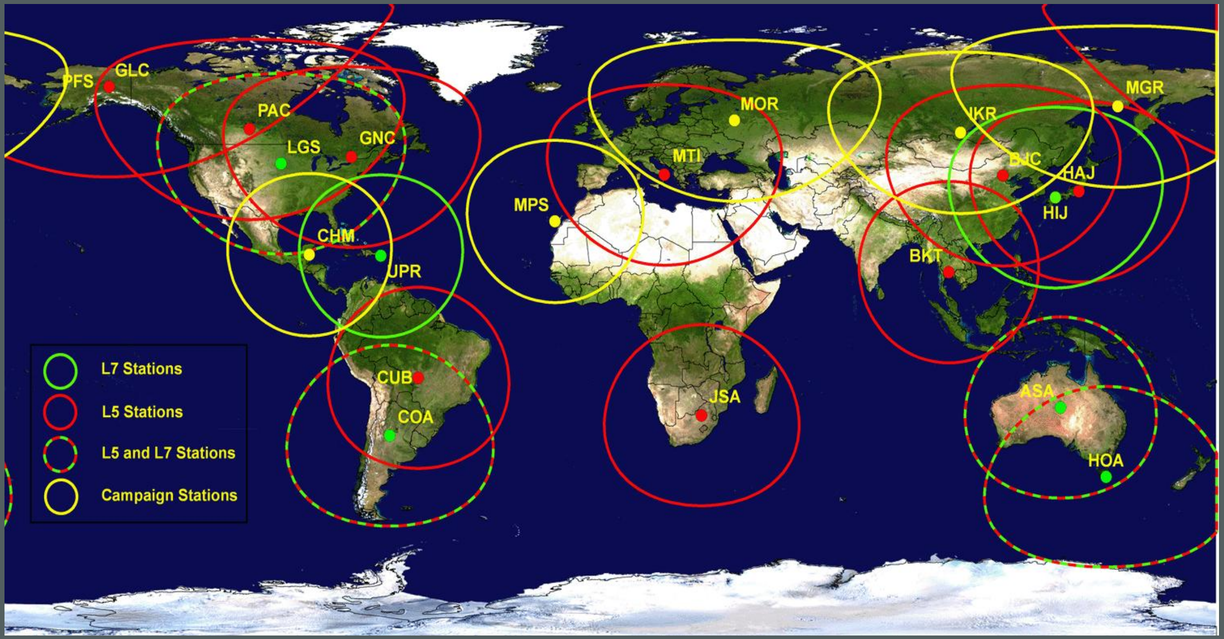
Expanding the Historical Landsat Archive – The Landsat Orphans



Landsat 1-3 MSS data that could not previously be processed

106,335 *new* Landsat 1-3 MSS scenes added to the US archive

Expanding the Landsat Archive - Global Archive Consolidation



An estimated 3 million unique Landsat scenes acquired since 1972 are held in international locations.

297,790 scenes recently added from Argentina and Canada Landsat International Cooperator collections.

Australia, Indonesia, and Japan holdings will be added next.

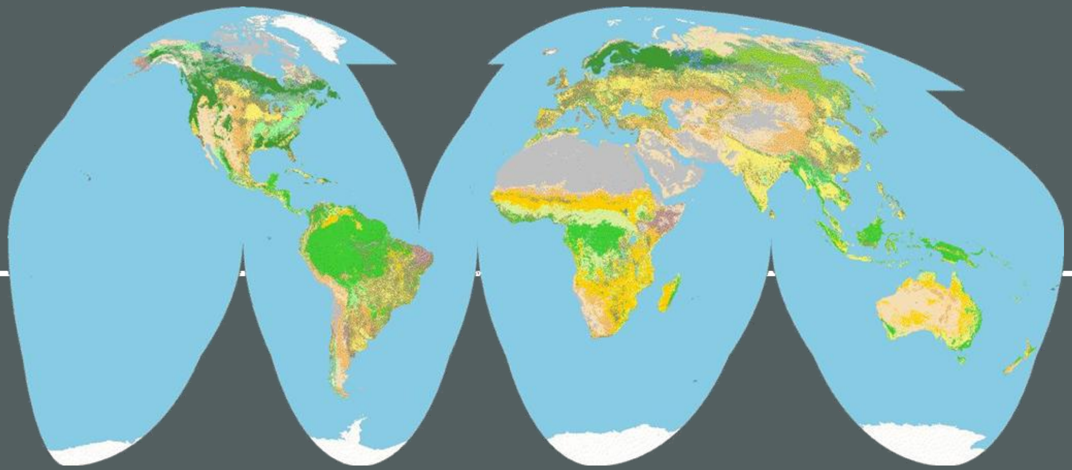
USGS

Status

Station	# in 1k's	%	Contact	Meta-data	Test Data	Technical Eval			Agree-ment	Archive Req	Data Recd
						MSS	TM	ETM+			
Europe (ESA)	2,090	42%									
Australia (GA-NEO)	629	13%									
Canada (CCRS)	532	11%									
China (CEODE)	449	9%									
Japan (RESTEC)	275	6%									
Brazil (INPE)	234	5%									
Argentina (CONAE)	195	4%				N/A					
South Africa (CSIR-SAC)	154	3%									
Thailand (GISTDA)	90	2%									
Germany (DLR) @ESA	87	2%				N/A	N/A				
Saudi Arabia (KACST MAW)	69	1%				N/A		N/A			
India (NRSA)	51	1%						N/A			
US (U of Puerto Rico)	42	1%				N/A	N/A				
Ecuador (CLIRSEN)	40	1%				N/A		N/A			
Pakistan (SUPARCO)	24	<1%				N/A		N/A			
Japan (HIT)	21	<1%				N/A	N/A				
Indonesia (LAPAN)	8	<1%				N/A					

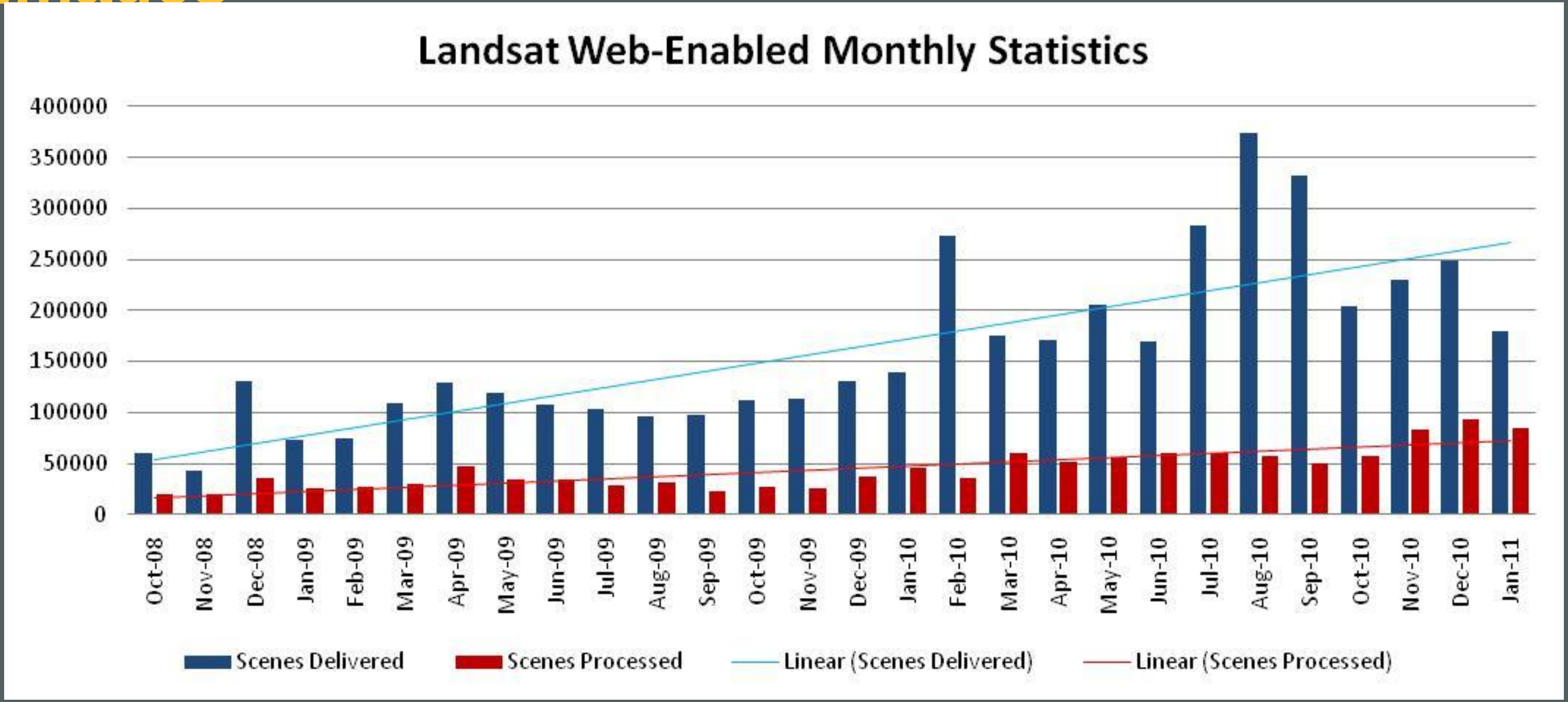
The Landsat Revolution…

- **In October, 2008, the USGS made the entire 38-year long Landsat archive (2.6 million scenes) available to anyone via the Internet at no cost.**
  - *The opening of the Landsat archive and the continuation of the Landsat record is a revolution that has affected the future of moderate resolution Earth observations*.



USGS

Landsat Monthly Processed and Downloaded Images



- **FY09 (Oct 2008 – Sep 2009)**
  - Delivered: 1.14M
  - Processed: 358K
- **FY10 (Oct 2009 – Sep 2010)**
  - Delivered: 2.48M
  - Processed: 567K
- **FY11 (Oct 2010 – Jan 2011)**
  - Delivered: 862K
  - Processed: 319K

USGS

Landsat Level 1T (L1T) Specification

- Pixel size: 15m/30m/60m
- Media type: Download (no cost)
- Product type: L1T (precision & terrain corrected)
- Output format: GeoTIFF
- Map projection: UTM
- Datum: WGS84
- Orientation: North up
- Resampling: Cubic convolution

USGS

Landsat holdings are accessible via:
GloVis (glovis.usgs.gov)
Earth Explorer (earthexplorer.usgs.gov)

Landsat Climate Data Record (CDR) and Essential Climate Variable (ECV) Plans

- Provide historical and contemporary science-quality, validated, quantitative information on land surface conditions and change
- Consistent with international standards (Global Climate Observing System) for higher level satellite data products

- Initial plans:
  - Surface reflectance and surface temperature products for Landsat TM and ETM+ data in 2012, and LDCM OLI and TIR following launch
  - Leaf area index (NASA Ames)
  - Global land cover – annual continuous fields and 5-year thematic classifications

Obama Proposal Puts USGS in Charge of Future Landsats - *Space News, February 21, 2011*

"U.S. President Barack Obama is asking Congress for $99 million next year to establish a permanent budgetary and managerial home within the U.S. Geological Survey (USGS) for the Landsat series of Earth imaging satellites."

Following Congressional Approval:

- The National Land Imaging Program is established
- Landsat becomes an operational mission
- Development of two new satellites is authorized - Landsat 9 (2018 launch) and Landsat 10 (2023 launch).

Summary

- Landsat is used worldwide and represents the standard against which other systems are measured.
- Web-enabled Landsat data is revolutionizing Earth observation science and applications.
- LDCM and Landsat 9 are the next steps in ensuring Landsat continuity.
- Natural resources management organizations need an operational Landsat program in order to justify and protect investments.
- Active input from the user community is an important part of a successful Landsat program.

My Thoughts (Curtis Woodcock, aka non Government Employee)

If you are not a government employee, make your thoughts on the importance of Landsat known to your congressional representatives and the appropriate subcommittee in congress! Now!!!

It's the politics, stupid!!!

USGS Realignment, Science Planning, and FY 2012 Budget

Matthew C. Larsen

Associate Director
Climate and Land Use Change

USGS Realignment

Director

Deputy Director

- Associate Director Core Science Systems
- Associate Director Ecosystems
- Associate Director Climate and Land-Use Change
- Associate Director Energy, Minerals & Environmental Health
- Associate Director Natural Hazards
- Associate Director Water Resources

USGS

Global Change Science Strategy

USGS Core strengths identified:

- Fundamental and applied science
- Long-term research and monitoring
- Integration of climate and environmental data
- Consistent data collection and synthesis
- Multi-scale studies
- Synthesis, assessment, modeling
- Comprehensive characterizations (based on mapping, monitoring, research)
- National / global presence
- Fundamental process studies
- National-scale mapping

USGS

Global Change Science Strategy

Defines 6 programmatic goals for global change science over short-term (1-5 years) & longer-term (5-10 years), along with strategic actions, products and key partnerships.

Progress towards the six interconnected goals will improve understanding of:

- rates, causes and impacts of past global changes;
- the global carbon cycle;
- land use and land cover change rates, causes, and consequences;
- droughts, floods, and water availability under changing land use and climate;
- coastal response to sea-level rise, climatic hazards, and human development; and
- biological responses to global change.