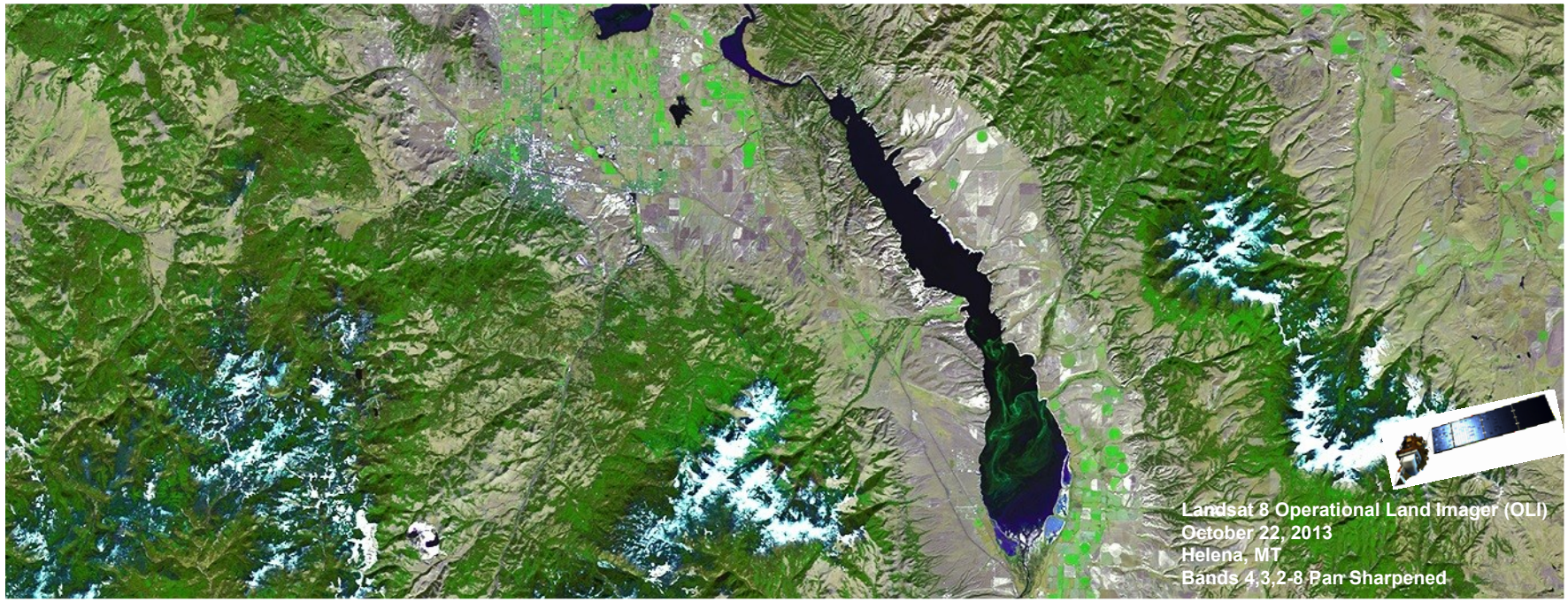
Landsat: Today and Future Missions

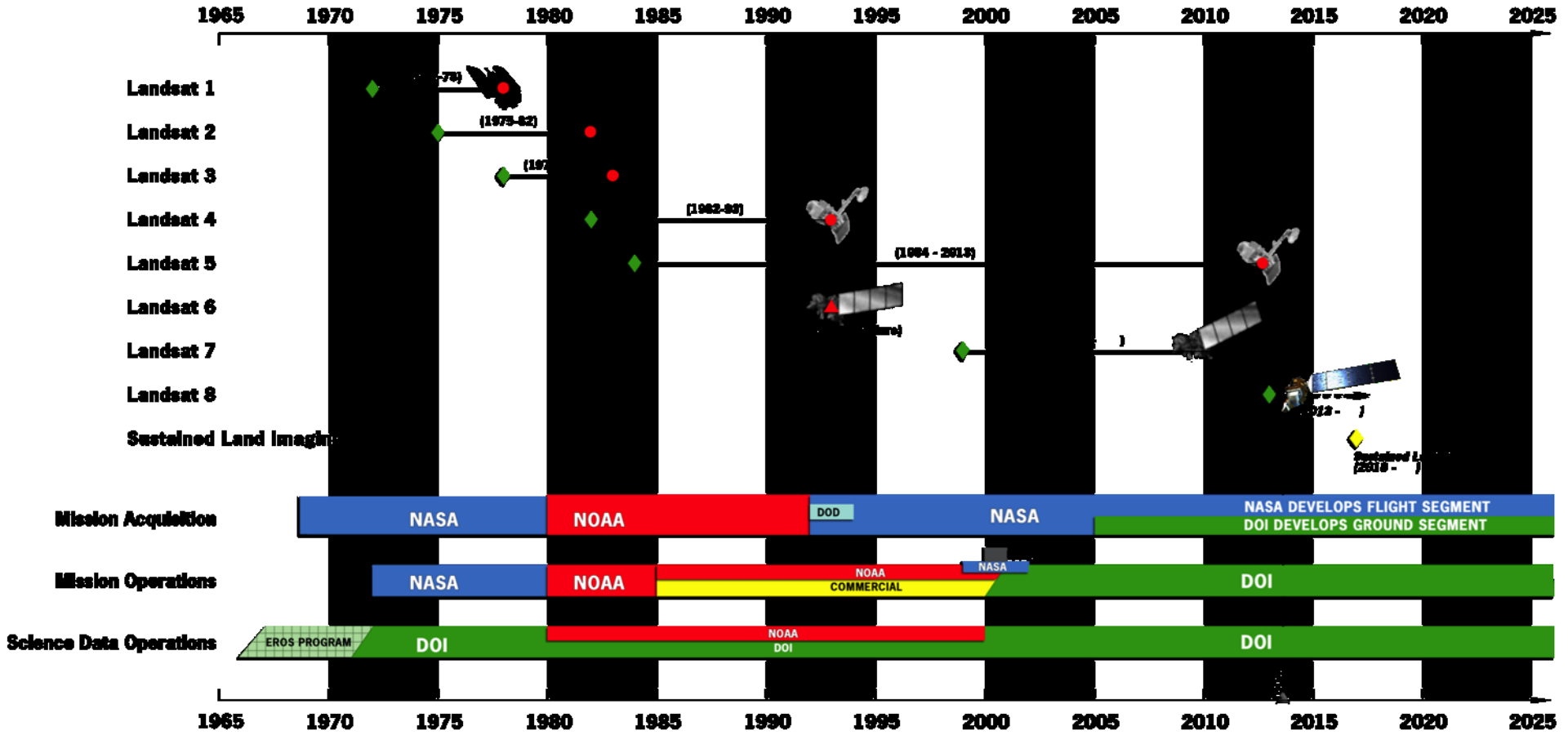
WSWC, Helena MT, July 15-18, 2014



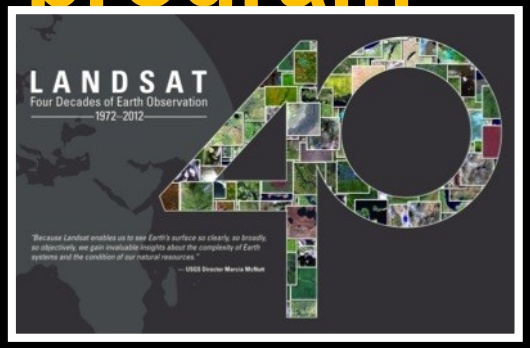
Dr. Frank Kelly
USGS EROS Center

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

USGS/NASA Landsat partnership since 1966



A good time for the Landsat program



2012

- USGS and NASA celebrated Landsat's 40th anniversary
- Longest and most comprehensive record of the Earth's condition ever assembled

2013

- NASA launched Landsat 8 and handed operational control to USGS
- Administration recognized the value of Landsat - committed to 20 years of Landsat at both NASA and USGS

2014

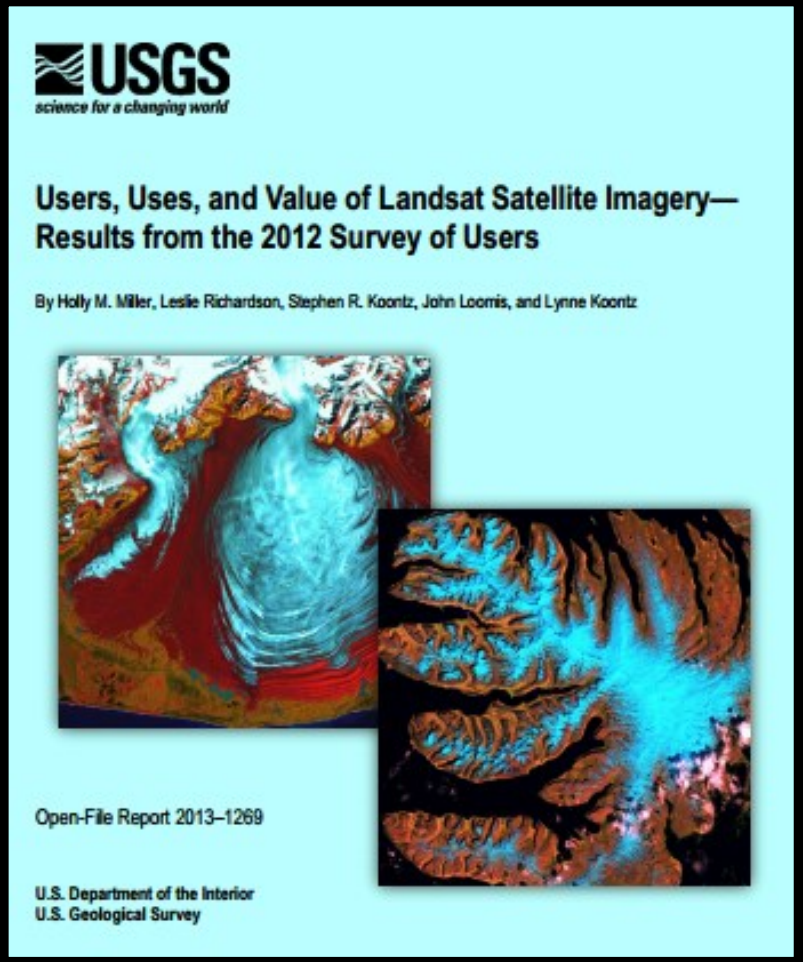
- Congress supportive of Administration's direction; requested a plan within 120 days
- NASA, USGS working toward near- and long-term plans

The Value of Landsat: 2012 Survey of Users

Conservatively estimated, Landsat's value to U.S. users is $1.8 Billion/year.

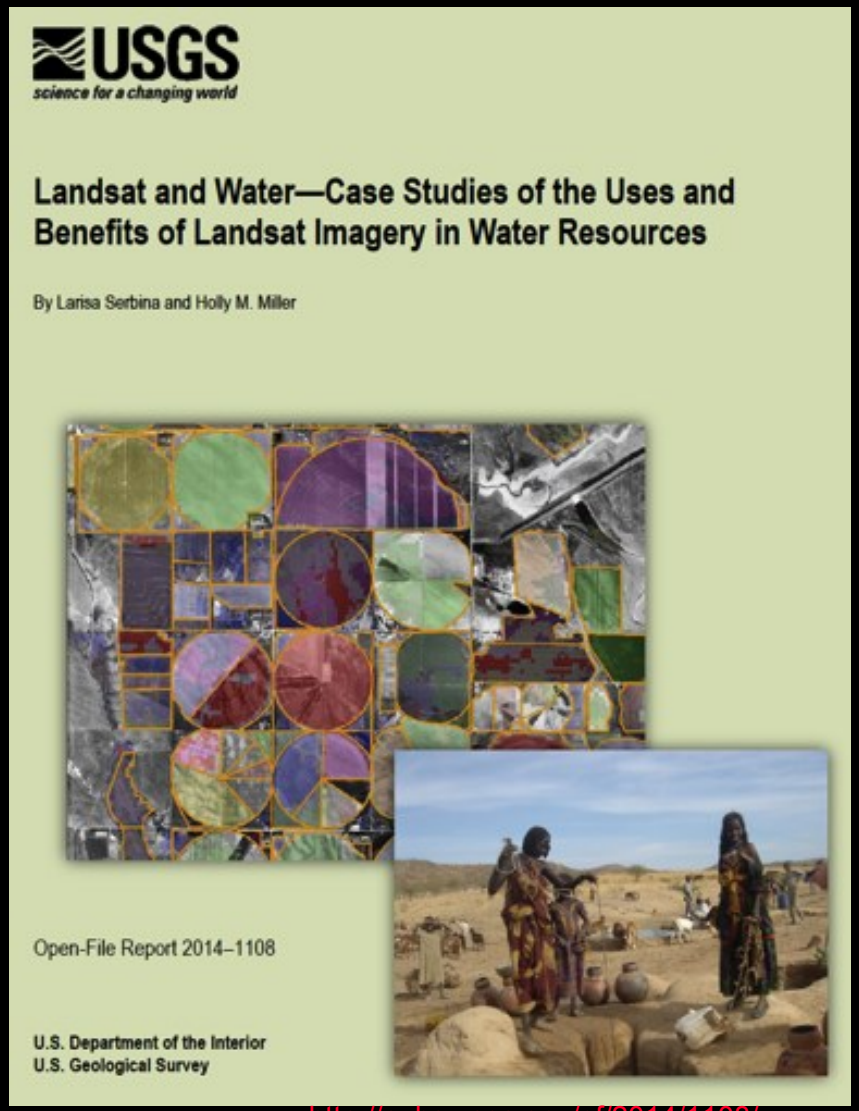
2/3 of applications require 8-day repeat (crop productivity, fire assessment, flood monitoring, irrigation management, etc.)

1/3 of applications require thermal data



Miller et al., 2013

New studies: Value of Landsat in Water Resources



http://pubs.usgs.gov/of/2014/1108/

- Federal Use of Landsat Imagery in Water Resources
- Intrastate and Interstate Water Management
- Irrigation in Agriculture
- Streamflow Water Rights
- Water Dispute Settlements
- Water Exploration
- Flood Mapping and Monitoring
- Land Cover Mapping

"Landsat is an American treasure… The data produced by Landsat plays a vital role in managing America's natural resources and the industries and jobs that rely on those resources."

Senator Barbara Mikulski

May 30th Transition: NASA to USGS

"The land and water resource data from Landsat 8 is a great asset to agricultural producers and others in both the public and private sectors. I salute the professionals at NASA and USGS who have worked to make this resource available for decades, and into the future"

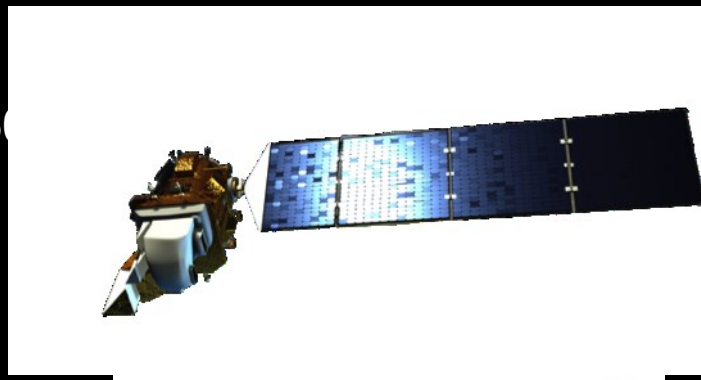
Senator John Thune

One year post-launch

Operational Status

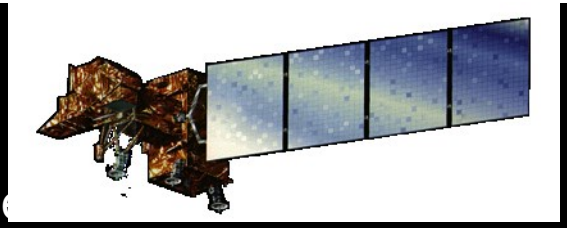
Landsat 8

- Collection increased from approximately 550 to 65(scenes per day;
- Has a 5-year design life and 10 years of fuel



Landsat 7

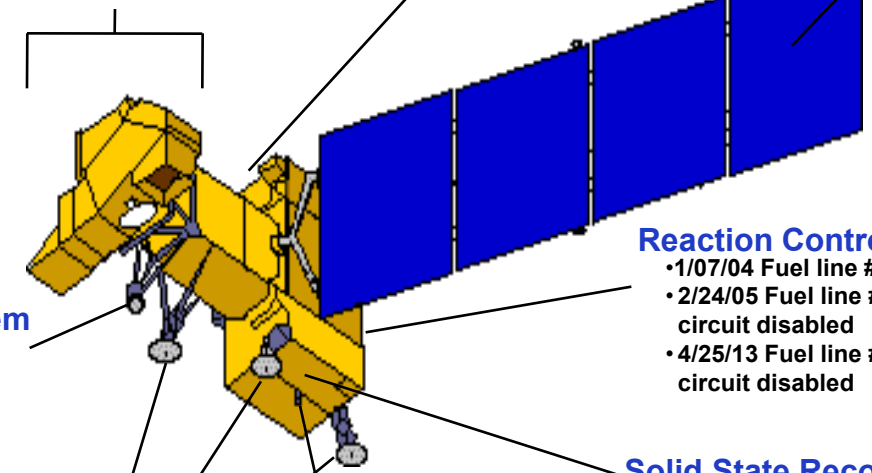
- Collecting over 400 new scenes per day;
- L7 collection strategy modified to concentrate on contin(coverage; L8 capturing islands & reefs
- Could last through 2017, though well past its design life and with several failed parts



With 2 satellites on orbit, USGS is capable of collecting data for any location on the land surface every 8 days

Landsat 7 Spacecraft Status

15 years of on-orbit operations



Enhanced Thematic Mapper +
- 5/31/2003 SLC Failure
- 4/01/2007 SAM -> Bumper mode

Electrical Power System

Batteries:
Performance nominal

Solar array:
- 5/14/2002 Circuit #14 Failure
- 5/16/2005 Circuit # 6 Failure
- 8/13/2008 Circuit #14 partial recovery
- 14 circuits remain operating
- No impact to ops

Reaction Control System
- 1/07/04 Fuel line #4 thermostat #1a failure
- 2/24/05 Fuel line #4 thermostat failure; Primary heater circuit disabled
- 4/25/13 Fuel line #2 thermostat failure; Redundant heater circuit disabled

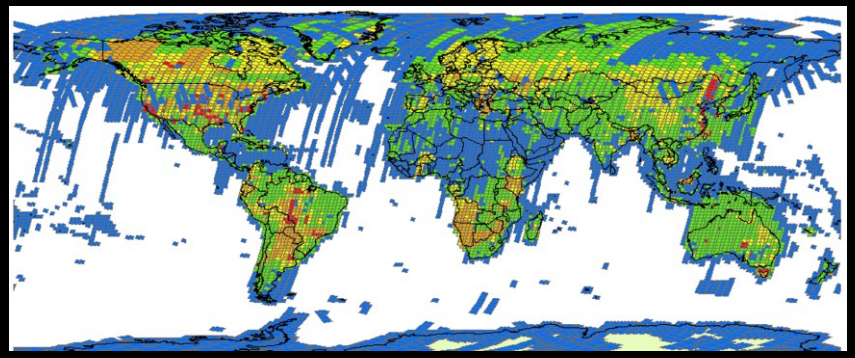
Attitude Control System
- 05/05/2004 Gyro 3 Shut Off
- Single gyro control system in development

Solid State Recorder
- 11/15/1999 SSR PWA #23 Loss
- 02/11/2001 SSR PWA #12 Loss
- 12/07/2005 SSR PWA #02 Loss
- 08/02/2006 SSR PWA #13 Loss
- 03/28/2008 SSR PWA #22 Loss
- 09/03/2008 SSR PWA #23 Recovered
- Each PWA is 4% loss of launch capacity
- Boards are likely recoverable

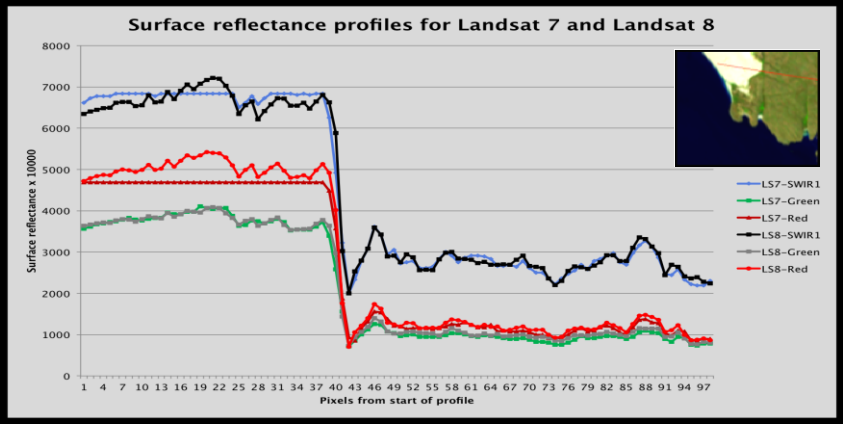
X-band System
Performance nominal

S-band System
Performance nominal

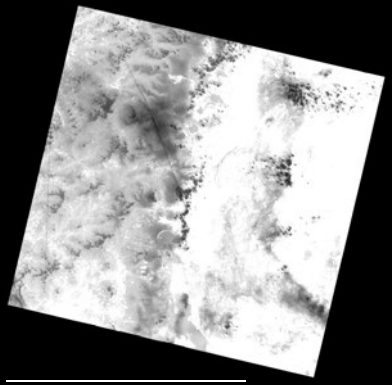
Landsat 8 Capabilities:

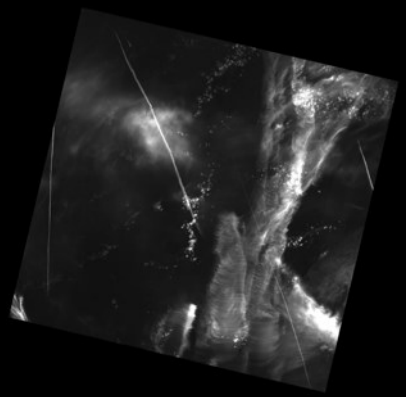


More image data



Better image data





New measurements

Better Data: Landsat 8 Lunar Image June 24, 2013

Landsat 8 calibration and instrument teams are scanning the moon, which is a very bright object with a very dark background, as a means to help further calibrate both TIRS and OLI.

Solving a 40-year problem

The Nation is remarkably close to solving a big problem for users of Landsat data

- NASA, with USGS, is conducting a Sustainable Land Imaging Architecture Study, with an implementation plan due this August to the Administration
- Congress, the Administration, NASA, and the Department of the Interior/USGS all agree on the importance of land-imaging continuity
- The USGS is concerned about meeting the need for near-term data continuity

What is the big picture…..

- Landsat 8 is operational, Landsat 7 is well past its design life and will run out of fuel in the next 3-4 years.
- Landsat 8 has ten years of fuel, while the instruments have a three-year (TIRS) and 5-year (OLI) design life.
- That means in about three years there's a significant threat to both spectral (thermal) and temporal (8-day revisit) continuity.

Sustained Landsat Program

- The recently released National Research Council report: "Landsat and Beyond: Sustaining and Enhancing the Nation's Land Imaging Program," stated "the acquiring entity must engage in a more collaborative relationship with the builder and be prepared to accept more perceived risk through less intrusive "light touch" oversight rather than the traditional very intrusive insight."

- Although probably not the way to go for bold new technology development programs, such an approach seems entirely appropriate for management and acquisition of rebuilds and lower-risk projects.

- NRC Report Calls for Sustained Landsat Program, the report does not, however, recommend who should oversee the program —

- The Obama administration proposes keeping it at NASA and USGS …

Congress is not silent….

- The CJS Committee "is concerned about the administration's approach towards the follow-on Landsat 9 mission, for which funds requested in fiscal year 2014 are extremely low."
- But the Committee also expressed its desire to significantly lower the mission cost cap, to approximately $650M, "a level substantially below that required for Landsat 8."
- The recent Landsat 8 mission came in around $1B including launch and ground system….Committee is setting a high bar!

The Executive is not silent….

- 2014 President's Budget designated $30.0 M for NASA to develop a plan, with the USGS, for 20 years of imaging beyond Landsat 8, due to OMB in August 2014

- 2014 Omnibus confirmed this direction and required a plan from NASA within 120 days (May 2014):
  - Language indicates Congress is highly skeptical of hosted payload or international partner concept for Landsat 9.
  - Requests a plan for how Landsat 9 will ensure data continuity with cap of $650M.

- Budget pressure is driving NASA to lower-cost options that will not meet users' needs

What direction to choose?

- We must reduce mission costs. One feasible way is to reuse flight and ground system hardware and software wherever possible.
- Buying systems on-orbit--allowing space system builders to provide launch services--is another possible way to reduce costs.
- In short, a reduction in mission costs is possible, but will require a change in current major program acquisition practices.
- Taken together, these approaches could conceivably reduce costs down to the level specified by the Senate language.

How do we want to evolve?

- **Budget profile is dominant driver within the trade space.**
- **There are multiple viable mission types that fall within the study constraints, and each have their own benefits and risks. These include:**
  - Landsat-8 Re-Build
  - Single satellite with double swath coverage (achievable by a scanning instrument, multiple telescopes, etc)
  - TIR only free-flying satellite and international partnership with ESA Sentinel 2
  - Disaggregated reflective band imagers and thermal imagers on separate satellite platforms don't perform as well overall.

Senate Language: June 5, 2014

"Landsat Data Continuity.—The Committee provides $68,100,000, $4,000,000 above the request, for a land imaging mission successor to Landsat 8. With Landsat 7 at risk for ending its mission life as early as 2017, the Committee is deeply troubled at the potential loss of 8-day continuous terrestrial coverage now provided through the Landsat satellite series. The Committee does not concur with various administration efforts to develop alternative "out of the box" approaches to this data collection—whether they are depending on commercial or international partners. Given the constraints in Federal funding and the absence of credible alternatives to a conventional land imaging mission that ensures Landsat data continuity, NASA should proceed with an acquisition in fiscal year 2015 for a mission to launch a follow on to Landsat 8 by not later than 2020 that does not exceed a cost cap of $650,000,000, inclusive of all launch vehicle costs. Such a mission shall maximize the utilization of non-recurring engineering efforts from Landsat 8 to maintain a relatively low level of project risk. In addition, as a follow on to Landsat 8, program reserves shall be limited to not more than 10 percent for the duration of the mission's development and all hardware contracts should be firm fixed price and reflect steep discounts over the price paid for comparable components for Landsat 8. The Committee notes that the notional land imaging fiscal year 2016 budget is now more than $100,000,000 below what is needed for a 2020 launch. Hence, the Committee expects the 2016 budget to reflect resources necessary to meet that launch date."

http://www.gpo.gov/fdsys/pkg/CRPT-113srpt181/pdf/CRPT-113srpt181.pdf

Departments of Commerce, Justice, and Science, and Related Agencies Appropriations Bill, 2015, p. 109

Administration Response: June 17, 2014

"**Future Science Missions**. The Administration appreciates the Committee's support for science missions, but is concerned about prematurely specifying elements of future missions while the missions are in a very early state of development. In particular, **the Administration believes the Committee's proposed approach to a follow-on Landsat mission is** not feasible within the bill's proposed cost cap of $650 million…"

http://www.whitehouse.gov/sites/default/files/omb/legislative/sap/113/saps4660s_20140617.pdf

Statement of Administration Policy (Senate) June 17, 2014

Why are we still studying?

- As we all know, Washington loves to do studies.
- USGS is happy to participate, and is working hard with NASA.
- Recent studies have demonstrated Landsat is a highly impactful program.

Many diverse uses of Landsat data include:

- Agricultural
- Mapping
- Fire/Disaster Management
- Carbon Inventory/Credits
- Land Use Planning
- Deforestation
- Global Change
- Flood management
- National Security
- Ecosystem Management
- Land Use/Land Cover Classification
- Water Resources Management
- Glacier Monitoring
- Insurance Risk Management
- International Treaty Management

- Landsat is clearly in the top-most tier of the Nation's earth observation missions, alongside other critical space infrastructure like GPS and the weather satellite programs.

Near term establishes long term

- We believe a program of this value merits two simultaneous pathways:
- We've been fortunate to have a partnership between NASA and the USGS working on a dual path….

****

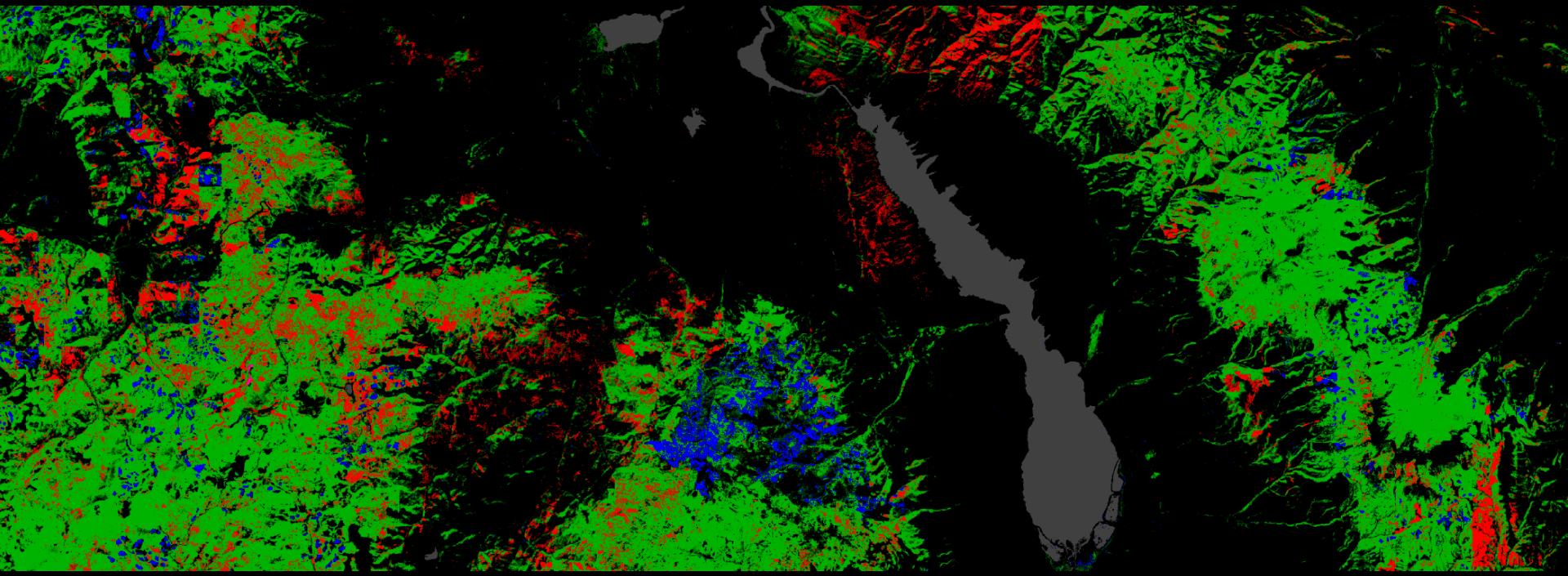
- It's imperative we start now on the near-term solution!!
- Let's not rely so much on luck in the future.
- Let's ensure there's an unbroken record of Landsat observations for future generations.

We cannot be silent….

- We continue to work with NASA to press for a resolution of the issue that is acceptable to both the USGS and NASA
- In a January 2014 meeting with Secretary Jewell, NASA Administrator Bolden committed that the rebuild option would get equal consideration in the NASA architecture study
- The OSTP and the OMB have made similar commitments. We are continuing to work this problem, NASA headquarters currently has control of the Architecture Study Team report
- To finally resolve the issue, additional involvement across stakeholder, user and customer communities will be needed
- We are remarkably close to solving a 40+ year challenge for the users of Landsat….

2000-2012 Forest Gains and Losses

Helena, Montana Area



Hansen et al., 2013. High-resolution global maps of 21st-century forest cover change, Science.