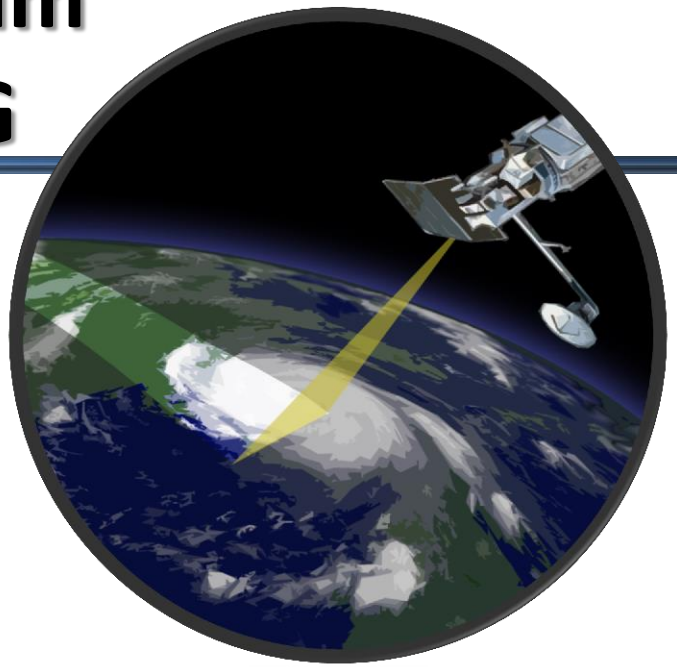
USGS
Land Remote Sensing Program
Status update for NGAC/LAG



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March 2017

Challenges

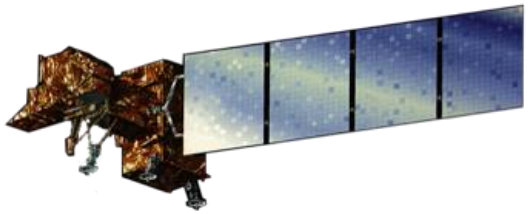
- **Communication–** synchronizing with **incoming administration**
- Congressional **Continuing Resolution for FY17 budget**
- **Anticipating budget cuts for FY18**
- Staying the course for a comprehensive NASA/USGS **"Sustainable Land Imaging Program"**
- Keeping pace with **rapid technological advancements** in space architectures, and data distribution & compute services
- **Landsat – Sentinel-2 harmonization**
- **Analysis Ready Data (ARD)**

Landsat operational satellite status

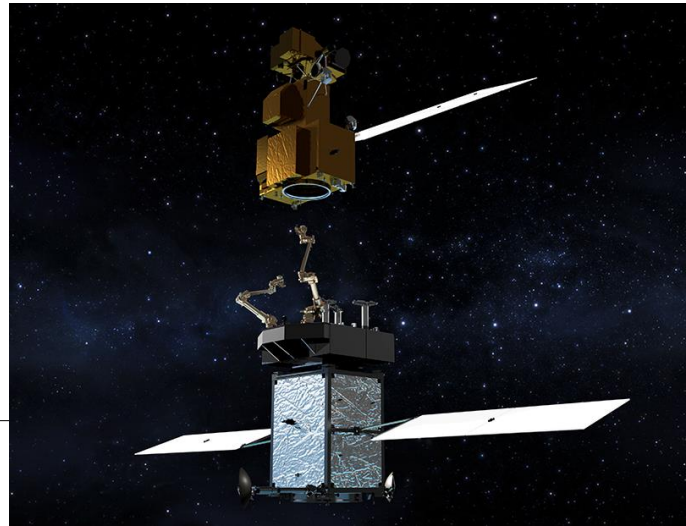
Landsat 8 (2013)

- Collecting up to 725 new scenes per day.
- Thermal Infrared Sensor (TIRS) continues to operate on B-side subsystems with observatory engineers closely tracking hardware performance.

Landsat 7 (1999)



- Collecting about 475 new scenes per day; about 22% of pixels missing per scene (faulty scan-line corrector)
- The latest fuel estimate projects L7 operating into 2021
- Restore-L (http://ssco.gsfc.nasa.gov/)



Together, Landsats 7 and 8 provide 8-day global revisit

USGS

USGS funding update for Landsat 9

- The USGS requires full funding of the 2017 President's Budget—a $15.4M increase over the 2016 budget—to maintain pace with NASA and ensure a 2020 Landsat 9 launch.

- A full-year CR in Fiscal Year 2017 without new funding identified for the USGS Landsat 9 ground system will result in significant budget challenges to USGS Climate and Land Use Change science activities.

- USGS is pulling out all the stops for this contingency for 2017, but the increasing budgets needed in the out-years remain an on-going challenge.

- Skinny PB18— "….includes funding for the Landsat 9 ground system…."

USGS

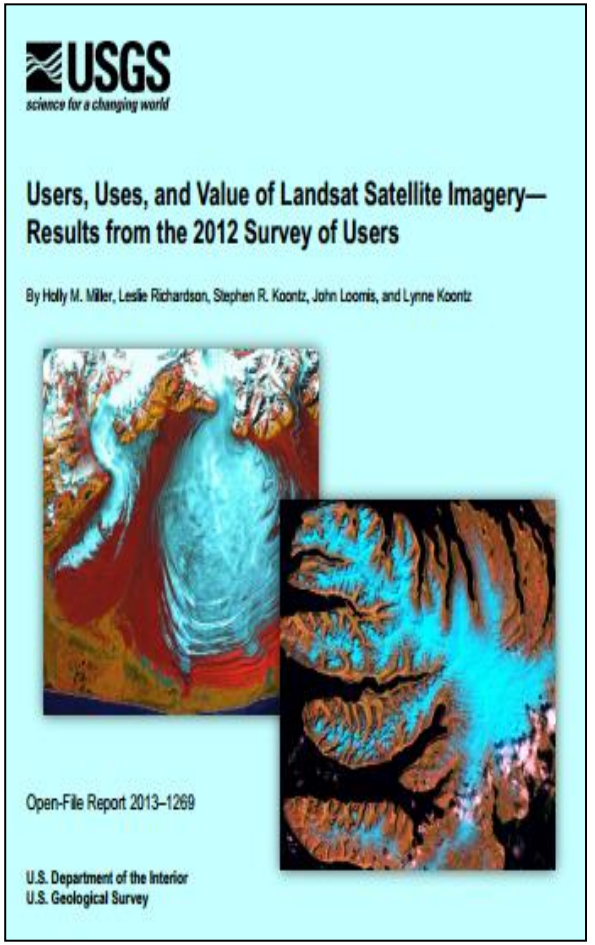
Updating Landsat value proposition in 2017

2012 Earth Observation Assessment (EOA) **ranked Landsat second-highest in order of impact** across the Federal user community behind only GPS

- Spurred Administration push for 25-year Sustainable Land Imaging program

2013 USGS Fort Collins publication documented **Landsat's value to U.S. users at $1.8 billion per year**

- Conservative estimate, as it did not calculate the value of data redistribution
- Far exceeds multi-year development and operations cost of any individual Landsat mission



2017 Plans

- Promoting EOA 2016 report findings
- Promoting LAG findings
- Contingent valuation study by USGS Fort Collins
- Impact Assessment via USGS RCA-EO activity, particularly L10

Sustainable Land Imaging (SLI)

SLI NASA/USGS Inter-Agency Agreement (IAA) (2016)

Landsat 9 (target launch in late 2020)

- Upgraded Thermal Infrared Sensor (TIRS-2) design—from risk class C to B redundancy upgrades
- Upgraded Spacecraft and ground system design—transferring all 14 bits of resolution data from Operational Land Imager (OLI-2) to the ground (from 12-bit)

Landsat 10 (estimated launch ~mid-2020s)

- EVERYTHING IS ON THE TABLE at this point (e.g., small sat, hyperspectral, etc.)
- Measurements that enable **backward and forward assessments**
- Technology and requirements studies underway to support a 2018 decision point

Tremendous potential to leverage Sentinel-Landsat harmony

- **Successful Launch of Sentinel-2b, March 7, 2017 !!**

- **Sentinel-2C & 2D on the horizon (similar SLI-like vision)**

Agreement between ESA and USGS enables USGS to:

- Download/store S2 data from the ESA 'International Data Hub'
- Reformat the data into individual 100km tiles (maintaining SAFE format) in UTM/MGRS
- Distribute as Level 1-C product via EarthExplorer
  - 3-band full resolution browse also available (Sentinel2Look)

To date, the USGS has archived approximately 650,000 S2 scenes and distributed over 900,000 S2 products.

USGS

USGS Earth Resources Observation and Science (EROS) Center

- Manages 25.2PB (‘17) of science data (50% is Landsat); 12.5 PB in ‘14
- Last 12 months (from Aug ‘16) distributed 18PB of science data
- The Landsat archive is growing by ½PB/year.
- Once fully operational, the S2 archive will grow at 1.25PB/year.

What does Sentinel-2 mean for Landsat users?

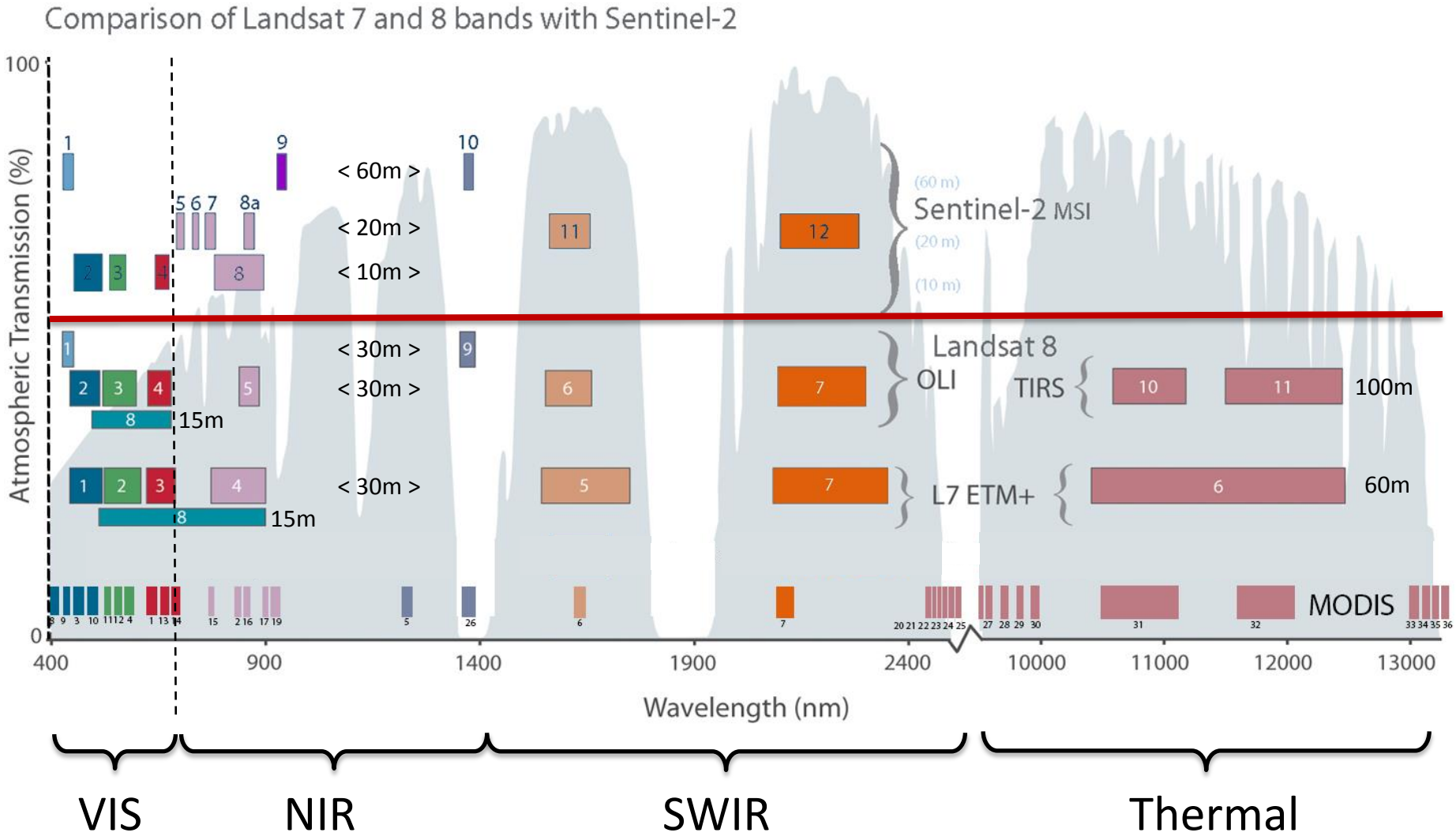
- Sentinel-2 is **"Landsat-like" by design** (although it does not have thermal infrared bands)

- Sentinel-2 data is expected to substantially augment Landsat data, increasing the **possible revisit over any one spot on the Earth's surface to just three days**, as long as two Sentinel-2s and two Landsats are in orbit at the same time.

- This frequency of revisit will help the USGS satisfy the increasing demand for rapid revisit required by operational applications, like **global crop monitoring** and the monitoring of natural resources and features such as forests, sea ice, snow cover, wildfires, and surface water.

- Sentinel-2 data available through the USGS may partially mitigate the risk of a **gap in data from the loss of either Landsat 7 or Landsat 8**.

Spectral comparisons



Landsat-Sentinel2 harmonization investigations

*Determining the relative **compatibility** Sentinel-2 offers the Landsat community in terms of usability for applications*

Assessment of Sentinel-2 characteristics to accomplish applications

- Known challenges include lack of thermal measurement, BRDF, data format, & non-WRS 2 orbital characteristics
- What applications does Sentinel-2 not satisfy? In other words, can Sentinel-2 by itself maintain Landsat data continuity?

Landsat Science Team

- https://landsat.usgs.gov/landsat-science-teams

Analysis Ready Data (ARD)

- **Significantly reduce the burden of processing** on applications scientists
- Standard Level-1T products serve as the input used for generating ARD
- From **scene-based, to seamless** (gridded) access
- The ARD product consists of Landsat top of atmosphere reflectance, ***surface reflectance***, and brightness temperature data that are consistently processed, gridded to a common cartographic projection (Albers), and accompanied by appropriate metadata to enable further processing while retaining traceability of data provenance.

USGS

Summary of Challenges

- Communication
- Continuing Resolutions
- Sustainable Land Imaging Program
- Rapid technological advancements
- Expand user satisfaction across the Federal Civil Community
- Landsat – Sentinel-2 harmonization
- Analysis Ready Data