



Landsat Status Update

LCLUC STM

April 2024

Chris Neigh
L8/9 Project Scientist
NASA GSFC

+ many, many other people who have supported Landsat over the years...



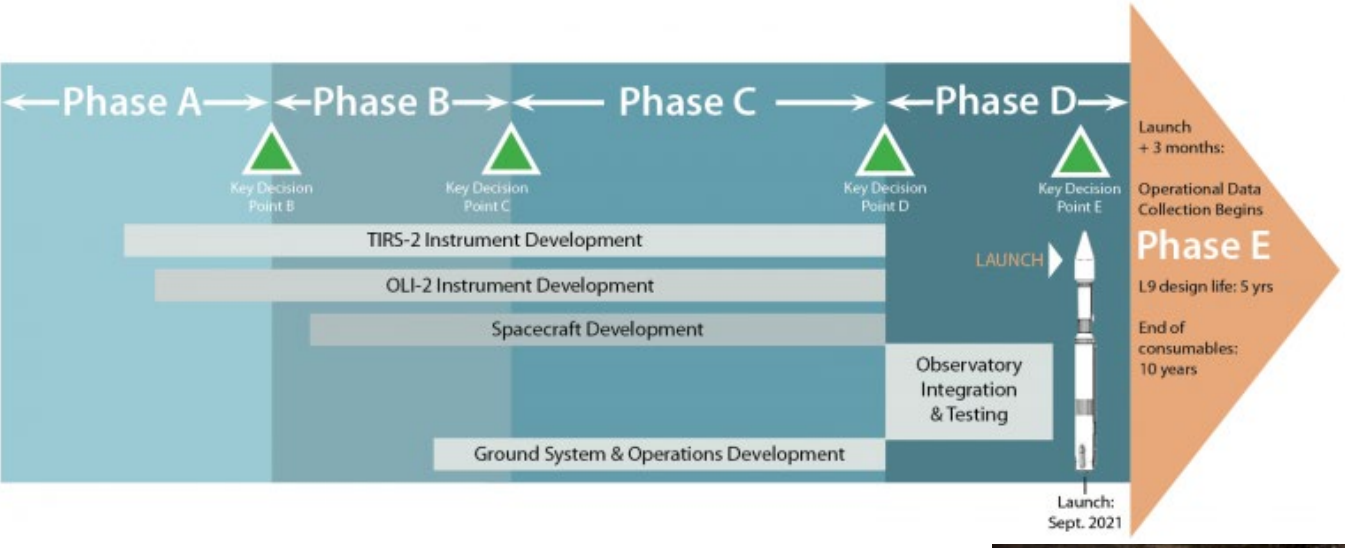
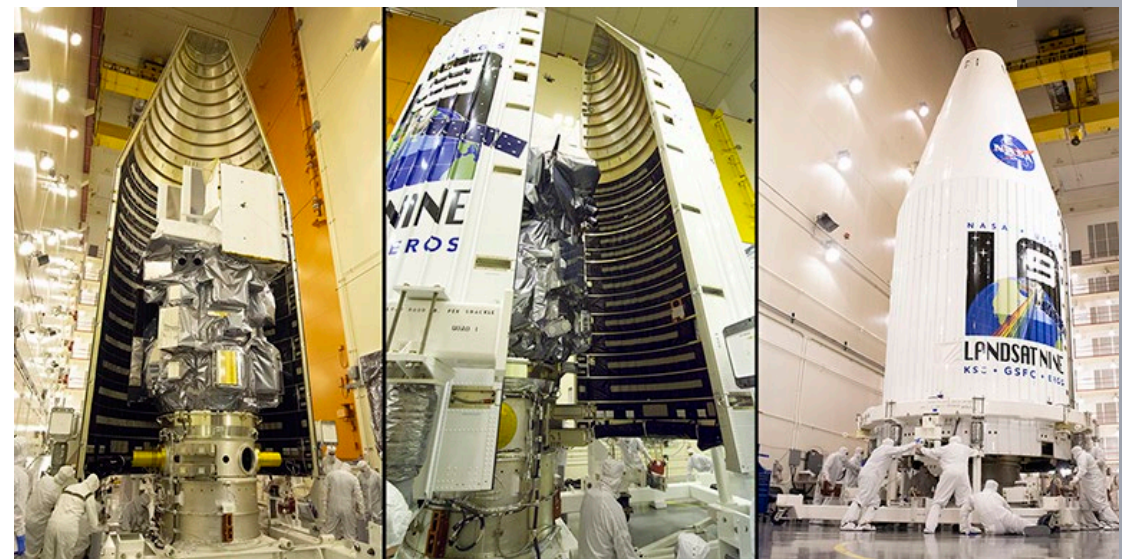
An aerial satellite image showing a city and its surrounding terrain. The city is located in the lower-left quadrant, with a dense grid of buildings and roads. The terrain is rugged and hilly, with a prominent river or stream flowing through it. The image is overlaid with a semi-transparent blue and purple gradient. The title "Landsat 9 Overview" is centered in the upper half of the image.

Landsat 9 Overview

L9 OLI-2 7/24/22

<https://landsat.visibleearth.nasa.gov/>

Under budget and ahead of schedule!

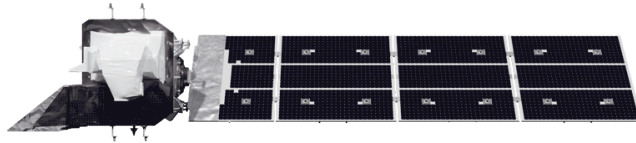


Level 1 Requirements Overview



Science Requirements

- 5-year mission life
- Seasonal coverage of global land mass
- Heritage Landsat 4-8 orbit (705 km)
- Image anywhere once every 16 days
- Simultaneously collect images for 9 reflective spectral bands (15/30m), and 2 thermal infrared bands (120m)
- Produce and distribute Level 1 data products:
 - orthorectified, band-to-band registration
 - at-aperture spectral radiance uncertainty of <5% (reflective) or <2% (thermal IR)



Mission & Spacecraft Performance

- Category 1 Project, Risk Category B mission
- 5 year on-orbit spacecraft design life
- 10 years of consumables, reserves for controlled reentry

Launch Requirements

- Risk Category 3 expendable launch vehicle

Education and Public Outreach

- Prepare and execute Public Outreach Plan

Mission Data Requirements

- Operate to collect and archive at least 400 scenes per day, with no changes that would preclude heritage Landsat 8 collection rate (740 scenes/day).
- Generate and distribute at least 400 Level 1 data products per day
- Nondiscriminatory access to Landsat 9 data
- Publicly release data processing algorithms
- Support a Landsat Science Team

All L9 Level 1 Requirements
have been met and exceeded

Science Benefits of Landsat 9 over 8



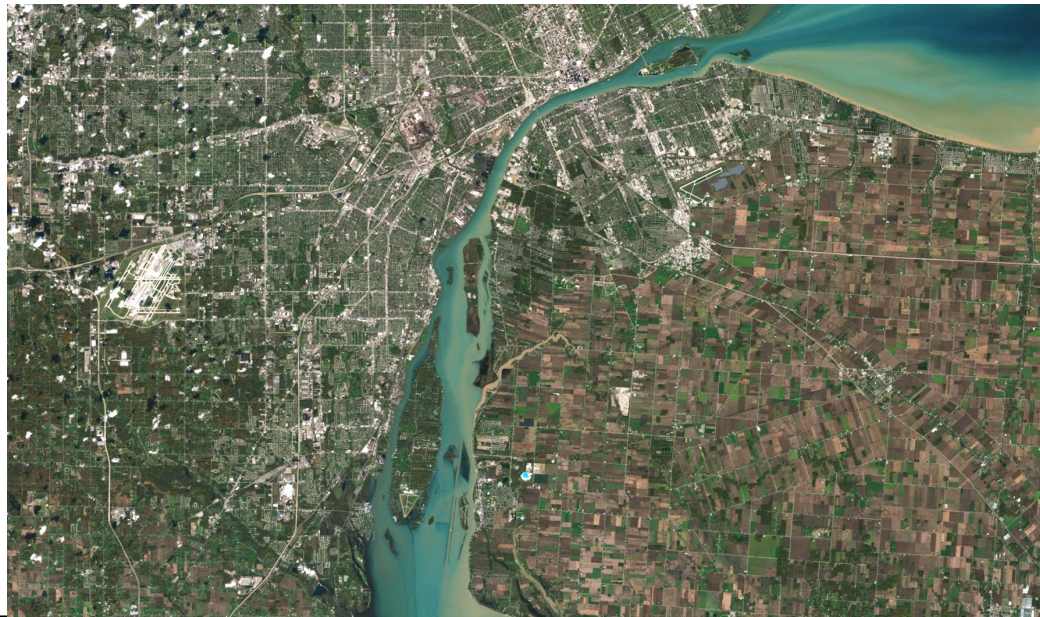
➤ **OLI-2 data transmitted as 14-bits (vs. 12-bits for Landsat 8)**

- ❑ SNR for dark targets improved by 25-30%
- ❑ Provides more accurate aquatic reflectance, and improved water quality & coastal ocean color products
- ❑ Potential additional benefits for dark vegetation pigments

➤ **TIRS stray light problems mitigated**

- ❑ More accurate atmospheric corrections become feasible via split window techniques using both channels

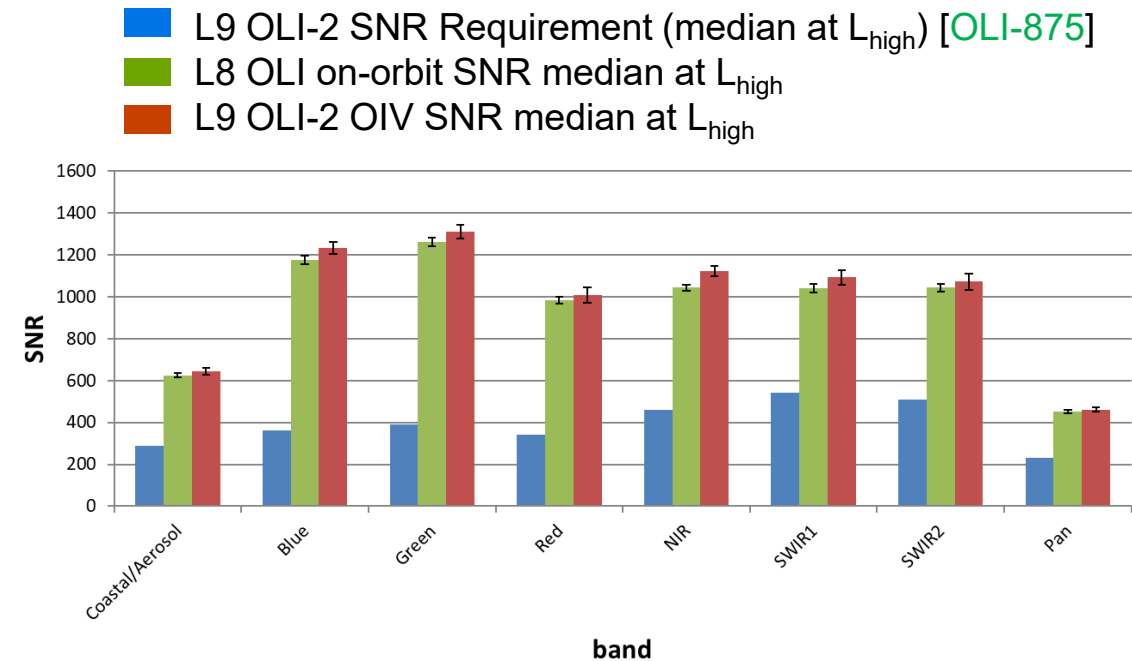
➤ **Two observatories with “state of the art” radiometry providing data every 8-days**



OLI and OLI-2 SNR Performance



#	Band	SNR Requirement@ L _{Typical}	Typical Radiance Level, L _{Typical}	L8 OLI SNR (12 bit) Median Performance	L9 OLI-2 SNR (14 bit) Median Performance
1	Coastal Aerosol	130	40	232	263
2	Blue	130	40	355	442
3	Green	100	30	296	366
4	Red	90	22	222	268
5	NIR	90	14	199	249
6	SWIR 1	100	4	261	314
7	SWIR 2	100	1.7	326	367
8	Pan	80	23	145	162
9	Cirrus	50	6	162	173



**OLI-2 SNR 2-3x better than requirement.
16-day radiometric stability 5x better than requirements**

Masek, J. G.; Wulder, M. A.; Markham, B.; McCorkel, J.; Crawford, C. J.; Storey, J.; Jenstrom, D. T. Landsat 9: Empowering Open Science and Applications through Continuity. *Remote Sensing of Environment* **2020**, 248, 111968. <https://doi.org/10.1016/j.rse.2020.111968>.

Landsat Mission Overview

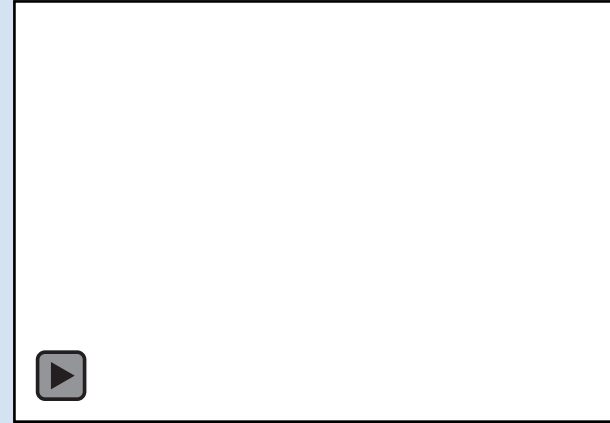


The Landsat 9 Project is jointly managed by NASA & USGS

NASA builds, launches, and performs on-orbit checkout



USGS manages the ground stations, conducts mission operations, and processes and distributes the data

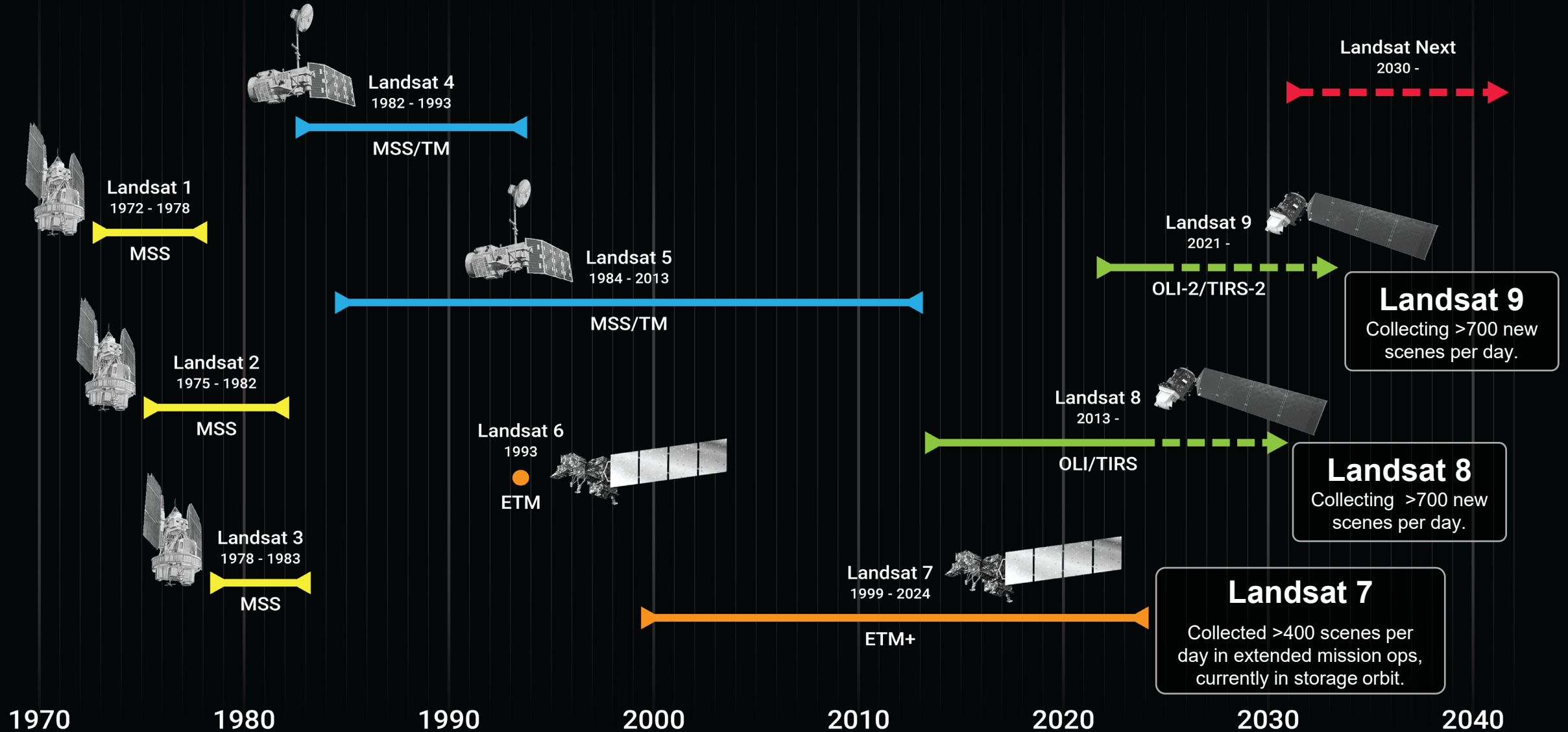


Landsat 8 integration, launch, and separation from rocket

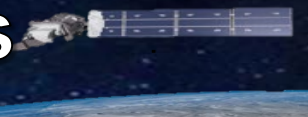


USGS Earth Resources Observation and Science (EROS) Center, Sioux Falls, SD

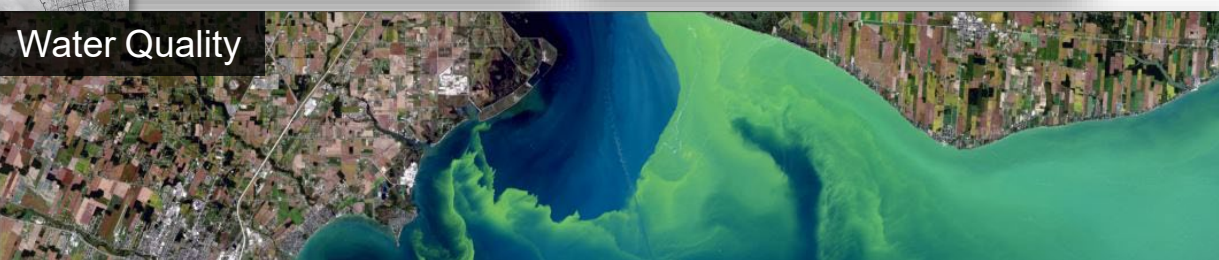
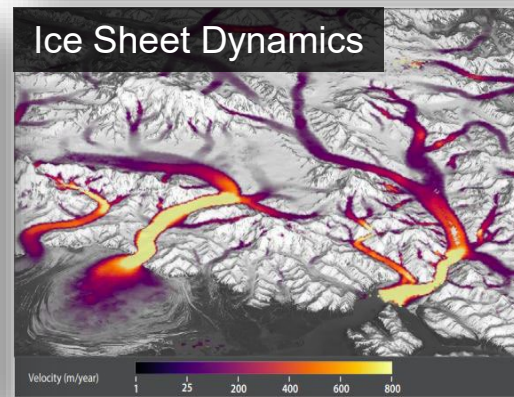
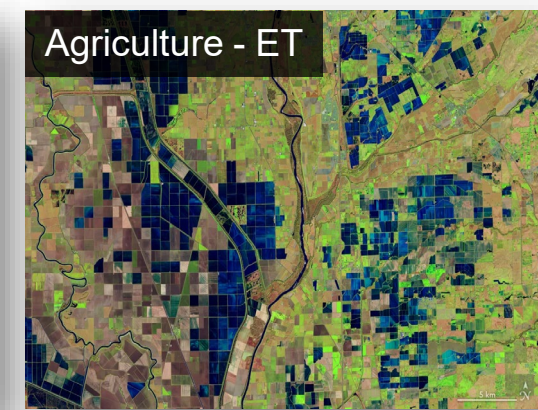
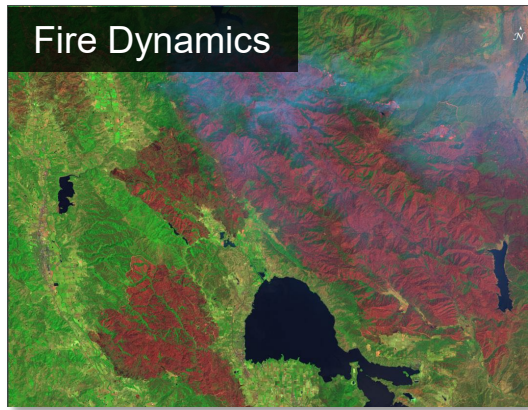
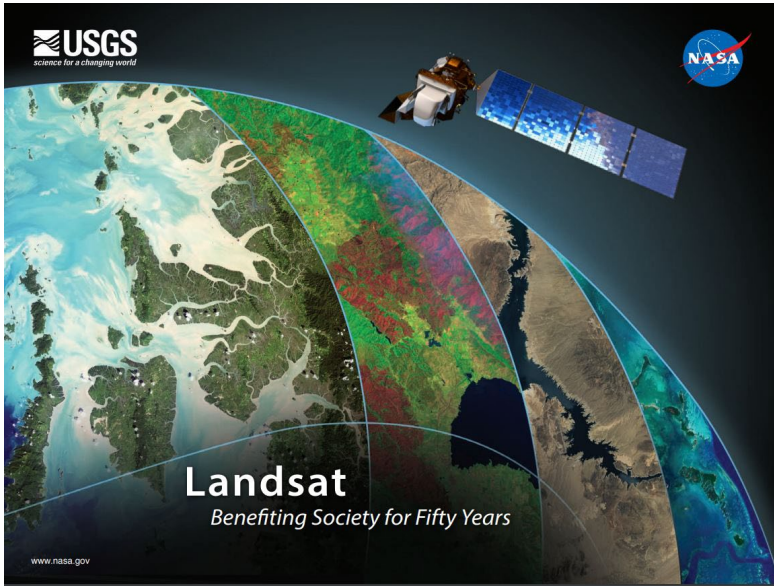
BUILDING ON THE LANDSAT LEGACY



Landsat Applications and Societal Benefits



Landsat provides 50+ years of multispectral imagery supporting key science and societal benefit areas:

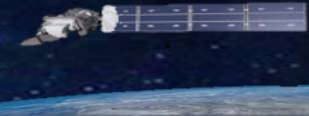


+ many more

Landsat 7 Status

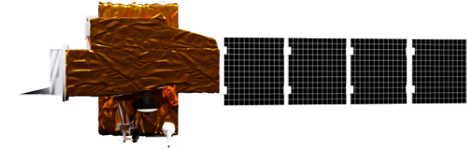


Landsat 7 Operations History



From Tom Cooke: Lead Ops/System Engineer Landsat 7; USGS/KBR/NASA Goddard Space Flight Center

- L7 has taken >2.8 million images of the Earth and safely deposited them into the global Landsat archive.
- L7 was running at approximately 450 scenes/day and downlinking them to sites around the world.
- The Flight Ops Team has conducted 244 orbit maintenance burns to control the orbit height/period, and 20 delta-inclination burns to control the orbit inclination and equatorial crossing time.
- L7 has suffered a few component issues but considering its advanced age >24 (Launched 4/15/99), it has held up extremely well.
 - 2002; Solar array circuit #14 failed. In 2008, it began producing power again!
 - 2003; Instrument (ETM+) scan line corrector failed.
 - 2004; Gyro #3 was shut off due to a sharp rise in output noise and a negative impact to the performance of gyros #1 and #2.
 - 2004; Primary fuel line heater failure.
 - 2005; Solar array circuit #6 failed.
 - 2007; ETM+ was placed into “Bumper mode” in response to wearing on the primary mirror turn-around spring bumpers.
 - 2013; Redundant fuel line heater failure. The team has a plan in place, to partially operate the failed heaters to keep the fuel lines in a safe thermal range.
 - 2014; The Remote Telemetry and Command box (RTC) autonomously failed from side A to side B.
 - 2014; A clock generator circuit in the power system autonomously failed over from the prime circuit to the redundant circuit.
 - 2019; calibration lamp #1 in the ETM+ failed, and a switch to lamp #2 was made.
 - 1999-2021; The solid-state recorder experienced anomalies ranging from memory boards shutting off to the controller locking up. These issues have caused a loss of science data at the time of the problem, but the FOT has always been able to recover the recorder to a functioning state, with minimal impact to long-term science objectives (Aside from slightly less storage space). The team has a plan in place, should it be needed, to recover some of the de-powered memory boards.



L7 Current Status and Orbit



From Tom Cooke: Lead Ops/System Engineer Landsat 7; USGS/KBR/NASA Goddard Space Flight Center

During the first week of April 2022, L7 took a series of retrograde burns lowering L7 into a new orbit.

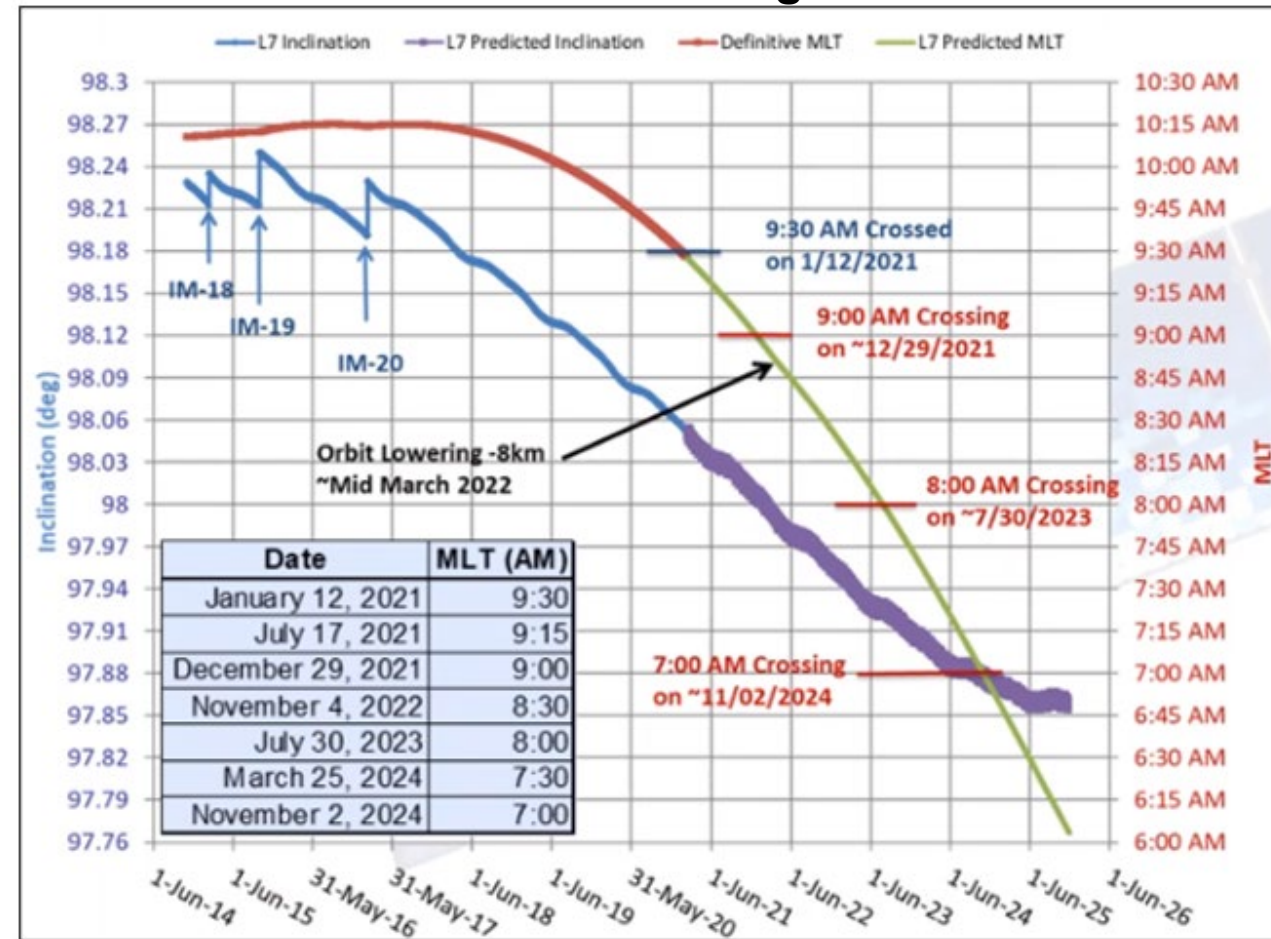
The new orbit was to support L7 extended mission operations:

L7 in preparation for supporting the OSAM-1 mission. OSAM-1 is a technology demonstration mission being developed by NASA, scheduled for launch in 2026. One of the OSAM-1 objectives is to rendezvous and dock with another spacecraft (in this case, L7), transfer fuel to the client spacecraft, and then release it.

- The L7 Flight Operations Team (FOT) has worked with the OSAM-1 team for several years now helping with information transfer, and operations development.
- Transition operations, sunline slewing, RF performance while in safe-hold, and many other aspects of the operation will be vetted during the test.



L7 MLT and b Angle



Landsat 7 Extended Science Mission

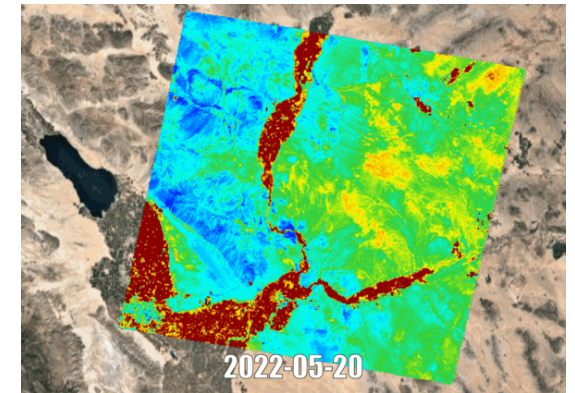
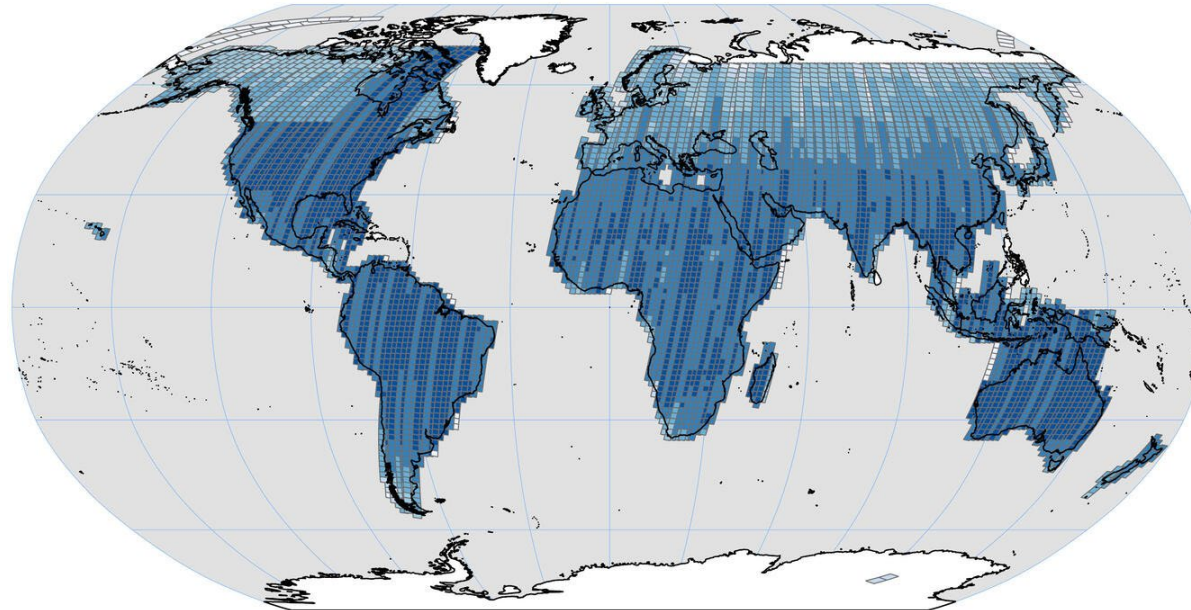


Landsat 7 satellite was lowered from the standard 705 kilometers (km) orbit to 697 km in April of 2022.

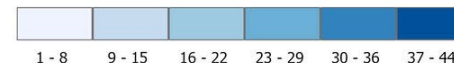
In the lower orbit, Landsat 7 is no longer on a repeating ground track, and data acquisitions were not aligned to the World Reference System-2 (WRS-2) used by Landsat 8 and Landsat 9. Additionally, Landsat 7 acquisition footprints have continually shifted in relation to the WRS-2 grid.

<https://www.usgs.gov/landsat-missions/landsat-7-extended-science-mission>

The ETM+ acquired about 450 images per day. Landsat 7 added over 175,000 scenes to the USGS Landsat archive from May 5, 2022 to January 19, 2024.



Landsat 7 Extended Science Mission Scenes
5 May 2022 - 19 January 2024



Landsat Science





Science of Remote Sensing

Volume 8, December 2023, 100103



The 50-year Landsat collection 2 archive

Table 1.

Improved absolute geolocation accuracy using Landsat 8 Operational Land Imager (OLI) harmonized with European Space Agency (ESA) Global Reference Image (GRI) (Section [3.1](#))

New Digital Elevation Model (DEM) used for orthorectification with improved vertical accuracy (Section [3.1](#))

Improved radiometric calibration particularly for Landsat 5 and 8 (Section [3.2](#))

Inclusion of Landsat 9 observations (Section [3.2](#))

Global coverage Level 2 Surface Reflectance (Section [3.3](#)) and Surface Temperature (Section [3.4](#)) Landsat 4–9 products

Expanded Quality Assessment (QA) bits for Landsat 4–9 (Section [3.5](#))

Consistent bit design between Level 1 and Level 2 (Section [3.6](#))

Inclusion of per-pixel solar illumination and sensor viewing geometry (Section [3.6](#))

Expanded U.S. Analysis Ready Data (ARD) tile grid to cover more of the Aleutian Islands, Great Lakes, and certain coastal regions (Section [3.7](#))

Improved latency between acquisition and availability of Landsat 8 products (Section [4](#))

Direct Landsat access and analysis via commercial cloud (Section [4](#))

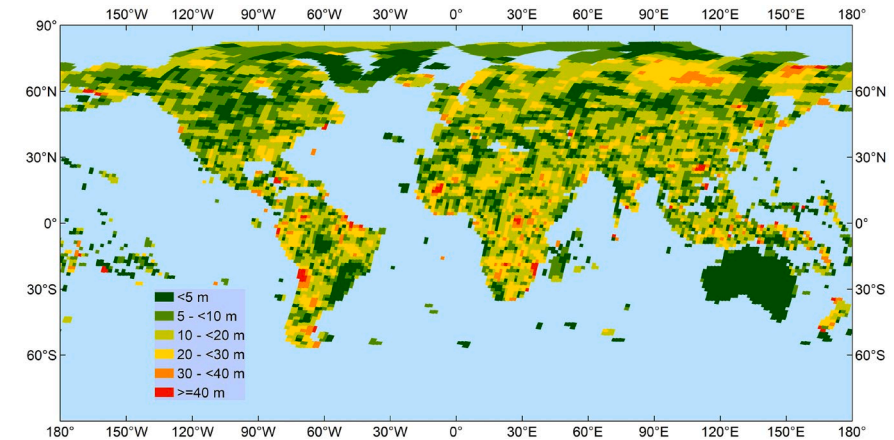


Fig. 1. Landsat WRS-2 path/row geolocation differences between the Collection 1 and Collection 2 Level 1 data products. The root-mean-square difference (RMSD) defined at each path/row are shown for Landsat 4–8.

Landsat Science Team 2018-2023



USGS Funded: Currently Landsat does not have a Science Team, the prior teams funding ended in June 2023.

Summary of long-term recommendations from the final meeting
Desert Research Institute, Reno, NV, February 7-9, 2023:

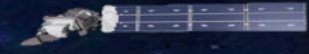
- Encourage long term archiving of all collections and input data at “golden tiles” – including preservation of the L0 and ancillary data – for long term science traceability/provenance.
- Bring MSS into the CONUS/Alaska/Hawaii ARD processing
- Consider ACIX and CMIX exercise outcomes to help guide future Landsat cloud and atmospheric correction algorithms.
- Include per-pixel uncertainty (defined in SI Units and not quantized into categorical classes) in future land surface reflectance and land surface temperature products.
- Include AOD (defined as a real number and not quantized into categorical classes) in future land surface reflectance products.
- Consider a mechanism for more open communication and harmonization of Landsat and ESA Sentinel-2 reprocessing concepts and schedules.
- Collection 3 R&D:
 - Land surface reflectance adjacency correction
 - Atmospheric correction of reflectance over inland and coastal water
 - Improve cloud and cloud shadow detection
 - Examine the impact of reducing the Tier-1 12m Root Mean Square Error (RMSE) geodetic accuracy criterion
 - Topographic correction of land surface reflectance and surface temperature
 - Global ARD
 - BRDF minimization – NBAR – should be invertible
 - Development of both LNext proxy (based on satellite data) and simulated (based on modelling e.g., DIRSIG) data sets to support LNext science algorithm development and code processing testing and feasibility studies



Neigh, C.S.R.; Crawford, C.J.; and McGinty E. (2023) Summary of the Final Activities of the 2018-2023 Landsat Science Team. *The Earth Observer*, **35** (5), 38-42.
<https://eosps.nasa.gov/earthobserver/sep-oct-2023>

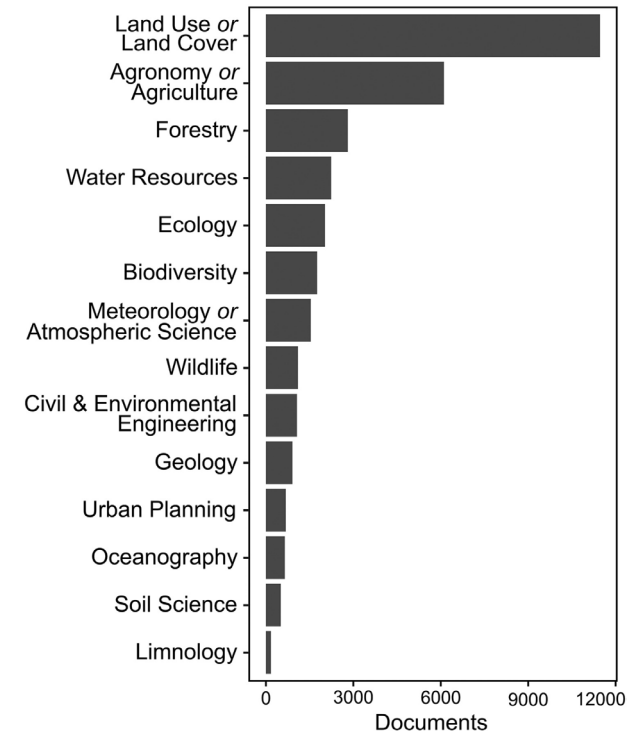
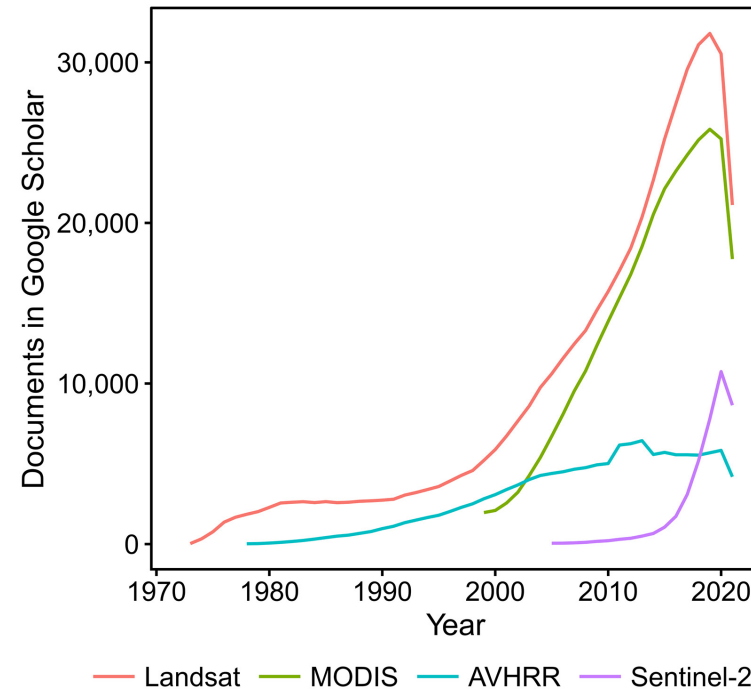
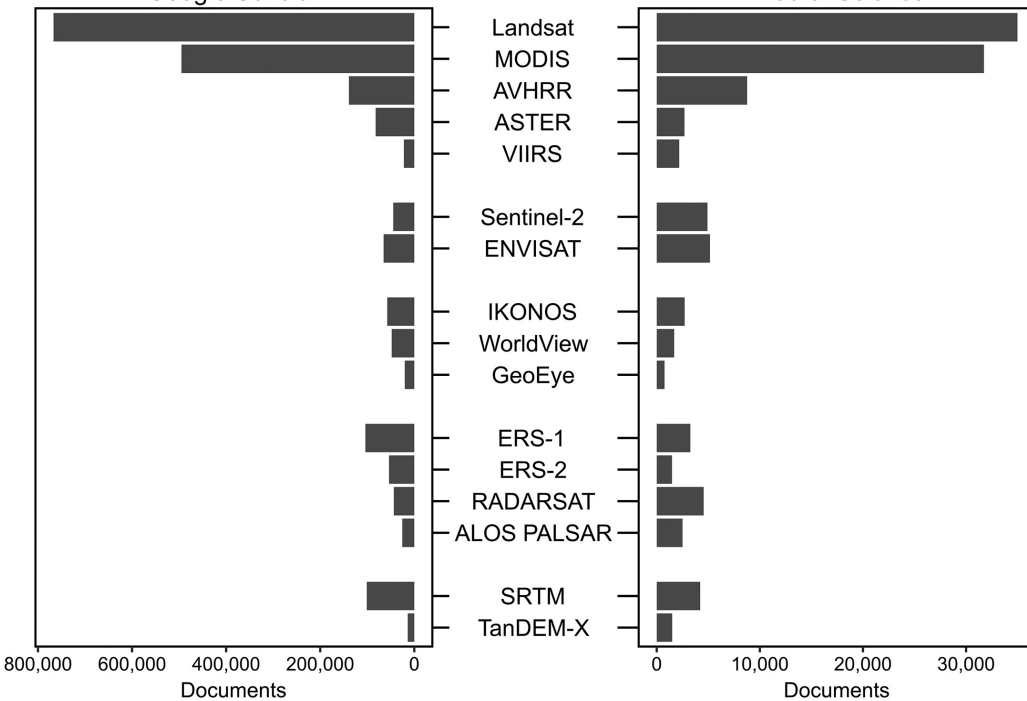


What has been the Impact of Landsat on Science?



Google Scholar

Web of Science




>1,600 Peer reviewed Landsat publications per year.

The background image is a composite of satellite data. On the left, a brown-toned urban grid is visible. In the center, a complex river delta system is shown in shades of blue and cyan. On the right, a large, swirling storm system is depicted in various shades of blue, with a distinct eye-like structure. The text is overlaid on the top portion of this image.

Landsat Communications and Public Outreach

Landsat Science News Digest






Landsat Science News Digest

February 2024

Landsat Science News

February 13, 2024
Landsat 2023 - A Year in Review

A delve into Landsat-based studies revealing the environmental impact of river mining, the decline in global lake water levels, and the risks of rising sea levels on coastal habitats. Plus, a sneak peek at what the future of the Landsat program holds with the introduction of Landsat Next.




February 27, 2024
Antarctic History Revealed by Landsat
Source: Kathryn Hansen, NASA's Earth Observatory

New Landsat-based research (Miles and Bingham, 2024) shows that while some Antarctic ice shelves have been thinning since at least the 1970s, widespread thinning accelerated in the 1990s.




February 13, 2024
Leveraging the Synergistic Power of Landsat and GEDI Data

By fusing Landsat data with forest structure products from the GEDI mission, researchers and scientists have unlocked a deeper understanding of complex forest processes and dynamics.



February 1, 2024
OpenET Study Helps Water Managers and Farmers Put Landsat to Work
Source: Emily DeMarco, NASA Earth Science Division

Researchers (Volk et al., 2024) have now conducted a large-scale analysis of how well Open ET is tracking evapotranspiration over crops and landscapes.



Summary of the newsletter sections:

Any news articles published to our website during the given month.

NASA Earth Observatory: Select Landsat Images from the given month. Picked at team's discretion based on what is compelling both story-wise and visually.

Reaching Out: Any outreach briefs published to our site for the given month.

Publication Spotlight: A Landsat-based journal article selected by (L8/9 Project Scientist).

Upcoming Outreach Events: Any outreach activities (or meetings) coming up in next month or two.

In Case You Missed It: Anything else interesting from the month that doesn't fit into above sections.



Landsat Communications Outreach – Social Media



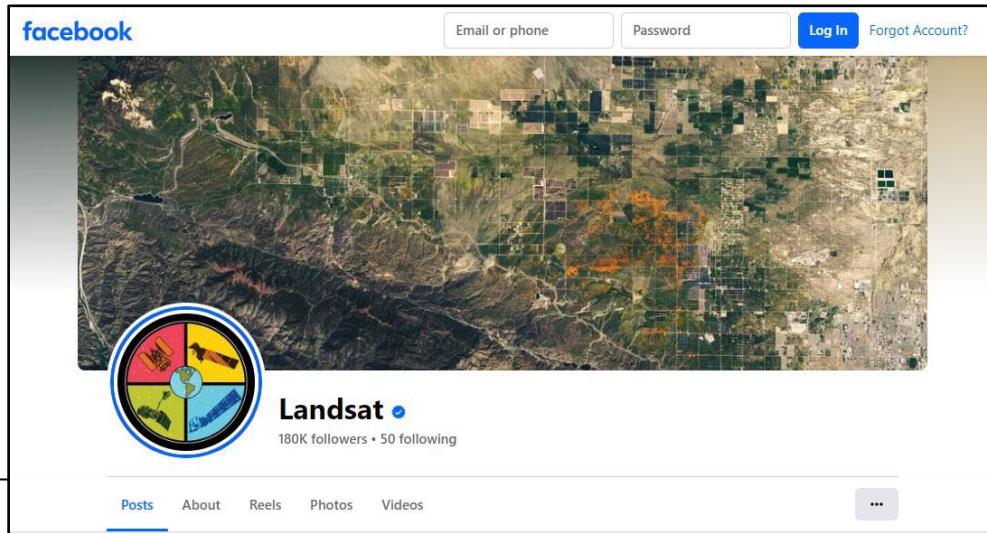
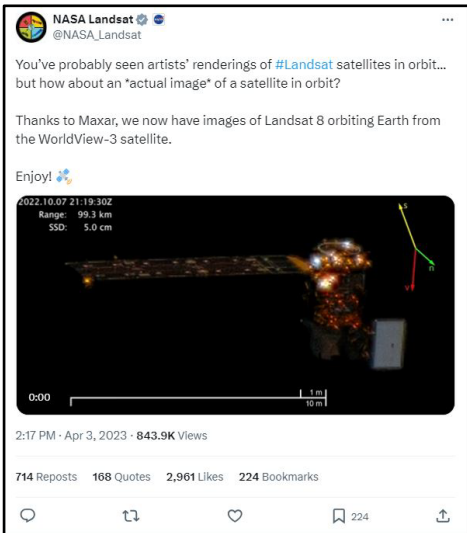
Have you seen an actual image of an orbiting satellite before?

On October 7, 2022, Maxar’s WorldView-3 satellite snapped this sequence of images showing Landsat 8 in orbit. The distance between the satellites ranges from between 91.4 to 129.9 km (56.8 to 80.7 miles). The orientation arrows provide Sun, Nadir, and Velocity information. The resolution of the Landsat 8 images in this sequence varies from 4.6 to 6.5 cm (SSD stands for Space Sample Distance).


After Maxar’s WorldView-2 satellite was hit by a non-tracked piece of space debris in 2016, Maxar used another one of its satellites to image WorldView-2 and assess the amount of damage—it was minimal. With the density of satellites and space debris both growing, Maxar realized that other commercial and government satellite operators may also need similar satellite imaging services for better space domain awareness. This technology could help identify space objects, assess on-orbit collision risks, aid satellite maneuver planning, and monitoring of end-of-life deorbiting and deactivated satellites.

As of December 2021, Maxar holds a license for non-Earth imaging (NEI) of Low Earth Orbit (LEO) satellites. The Landsat 8 images were taken as a demonstration of this technology.

<https://landsat.gsfc.nasa.gov/article/satellite-sees-satellite-landsat-8-in-orbit/>



Landsat Communications and Public Outreach




nature

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Article | Published: 23 August 2023

A global rise in alluvial mining increases sediment load in tropical rivers

[Evan N. Dethier](#) , [Miles Silman](#), [Jimena Díaz Leiva](#), [Sarra Alqahtani](#), [Luis E. Fernandez](#), [Paúl Pauca](#), [Seda Çamalan](#), [Peter Tomhave](#), [Francis J. Magilligan](#), [Carl E. Renshaw](#) & [David A. Lutz](#)

Nature **620**, 787–793 (2023) | [Cite this article](#)

4514 Accesses | 5 Citations | 297 Altmetric | [Metrics](#)

Example of LCLUC research communicated through Landsat Communications Team to the public:

Landsat Staff Producer/Videographer: Chris Burns – Translates LCLUC research to be consumed by the masses
<https://www.youtube.com/watch?v=xMEUC77xcMo>



DIY Spectrometer - STELLA



STELLA (Science and Technology Education for Land/Life Assessment):
A portable low-cost do-it-yourself (DIY) instrument that support science education and outreach through scientific engagement and inquiry.

STELLA An Open-Source DIY Handheld Spectrometer

Learners of all ages can gain hands-on experience in science, technology, and engineering as they follow freely-available online plans, instructions, and activities.

Mike Taylor, Ginger Butcher, Elle McGinty, Ross Walter, Jesse Barber, Science Systems and Applications, Inc., Paul Mirel, Hexagon US Federal, Dr. Petya Campbell, University of Maryland Baltimore County

NASA

ED31B-0907

<https://landsat.gsfc.nasa.gov/stella/>

"It's a very nice engagement tool – more than just images, it gets into the quantitative aspect of satellite data. It provides insight into the scientific process – how to think analytically. It also provides teachable moments about uncertainty in measurements – and appreciation of calibration and validation of NASA data."

WHAT IS STELLA?

STELLA is a handheld spectrometer, an instrument that records different wavelengths of light.

Landsat has been pivotal in tracking and understanding shifts on Earth by gathering precise observations from its surface for over 50 years. This data has been an invaluable resource for those overseeing land use, planning, and policymaking regarding our environment. But how does Landsat make these meaningful measurements?

DIY SPECTROMETER REQUIREMENTS

- Stability
- Affordability
- Accessible Parts
- Accuracy
- Ease of Use
- Documentation

STELLA was created as an entry point to understanding the science of remote sensing. It makes measurements of wavelengths similar to that of Landsat and shows you those measurements in real-time. For example the difference between green construction paper and green grass can be seen immediately by the disparity in near-infrared.

STELLA average reflectance of grass (green) acquired from 19 measurements by 11 different STELLA's over 3 full sun days between 12pm and 2pm eastern standard time at a distance of 100 meters. Landsat (blue) and ASD (orange) data obtained from USGS's Spectral Library Grass GDSV1 green BECCA AREF.

The STELLA instrument makes visible and near infrared spectral measurements. Landsat satellites also make spectral measurements in the shortwave infrared and thermal infrared regions not shown on the graphs. STELLA has a single, very broad thermal sensor which is less precise than Landsat's thermal sensors.

HIGHLIGHTS

- Website with build instructions, sample data, activities, and supporting open source github forum
- Ongoing calibration and validation
- Plug & play versions offer assembly without the need for soldering
- Drone variant successfully used on a quad copter
- 40 STELLA loaners have been distributed to educators across the U.S. to incorporate with their science lessons and provide feedback
- Data repository & Amateur spectral library (coming soon)

HOW IS STELLA EDUCATIONAL?

"The biggest value of STELLA is that it helps people 'think spectroscopically' and let them 'see' what our satellites - like Landsat - see." - Dr. Allison Leidner, NASA Program Manager for Climate & Resilience Applications

Science

Taking measurements with STELLA enables students to understand remote sensing science. This science involves the chemical and physical properties of a medium based on how light is reflected and absorbed by that medium. STELLA enables students to understand these aspects of remote sensing science using a learn-by-doing approach whereby data can be collected and analyzed by the same individual.

Technology

A study from 1990 says that organized purposeful participation in an activity fosters the learning of a given technological concept (Korwin & Jones, 1990). Using a STELLA step-by-step, learning is fostered about how the STELLA is used between its different sensors, parts and programming increasing knowledge about the way scientific technology is created. STELLA's programming is written in Python, with emphasis on readability so a novice will be able to understand it.

Engineering

STELLA helps educate how the modules, chips and sensors communicate with each other. Some STELLA versions require 3D printing using advanced designs such as tapers and interlocking pieces. Researchers have found that hands-on engineering creation provides for valuable possibilities across curricula, creates opportunities for social collaboration and problem-solving (Berman et al., 2016, Gourlet and Decortis, 2018, Tuhkala et al., 2019). STELLAs need electrical engineering if a problem arises which would facilitate a learning-from-mistakes approach (Lee, 2020).

Math

Math is used during data analysis, calculating reflectance from radiance measurements, plotting data, and using spectral indices to extract meaning from the data collected. Spectral Indices are mathematical equations using remote sensing measurements to monitor Earth system dynamics by exploiting chemical and biophysical properties of its subject. (Monteiro, D., 2023). The Normalized difference vegetation index (NDVI) is an example of one of these indices that uses measurements from the near-infrared and the red spectral wavelengths in a mathematical formula to assess plant health and density (Tucker, C., 1979).

HOW STELLA IS BEING USED?

STELLAs are being used all across the United States from Florida to Alaska. It has been used with astronaut candidates, in classrooms, field studies and a wide variety of conferences events and meetings.

STELLAs were used with the astronaut candidates. In July of 2023 STELLA was used for an astronaut candidate lesson. The Astronaut candidates took measurements with STELLA then viewed and analyzed their data on the Dataviewer in order to better understand and relate remote sensing concepts.

STELLAs are being used by teachers. Paige Williams, a PhD Candidate at Virginia Tech, led a workshop session entitled "STELLA Spectrometer: Overview and Exercise" for the GEO7+UAS Workshop in May 2023 through Virginia Tech's Geospatial Extension Program. This workshop is a five-day course which taught educators the workflow of drone operations and enhance their own curriculum to educate future drone pilots and geospatial scientists.

STELLAs are being used in the field. Dr. Fred Huemmrich (UMBC) and Dr. Petya Campbell (UMBC) took readings with the STELLA to verify field stability during their summer fieldwork for the project, "Clarifying Linkages Between Canopy Solar Induced Fluorescence (SIF) and Physiological Function for High Latitude Vegetation" in the boreal forests of central Alaska.

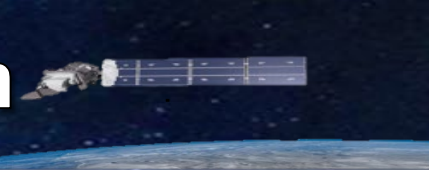
For references and more information



Summer 2023 - Astronaut candidates test STELLA devices outside during a hands-on activity in an Earth science class intended to lend a more personal perspective on how satellites operate. Credits: NASA / Allison Leidner

Landsat Cal/Val





➤ NASA/GSFC

- Kurtis Thome Co-Lead *
- Brian Markham Co-Lead **
- Ed Kaita/SSAI Lead
- Julia Barsi/SSAI (GLAMR Test Lead)
- Libo Ding/SSAI *
- Lawrence Ong/SSAI **
- Raviv Levy/SSAI
- Jeff Miller/KBR
- Phil Dabney/Instrument Scientist
- Jeffrey Pedelty Ball/NGSS on-site rep

➤ USGS/EROS

- Cody Anderson Co-Lead (radiometry)
- Michael Choate Co-Lead (geometry)*
- Jim Storey - Geometry Lead ** (on call)
- Esad Micijevic/KBR
- Obaidul Haque/KBR
- Pat Scaramuzza/KBR
- Alex Denevan/KBR
- ECCOE Vic Cal Team

LDCM/L8 pre-launch/commissioning heritage

- * Succession replacements
- ** Retired or part-time

➤ VENDORS/PROVIDERS

- OLI-2 – Ball Leads
 - Geir Kvaran (Radiometry Lead)
 - Kip Gwin (Geometry Lead)
- TIRS-2 – GSFC Leads
 - Joel McCorkel (Calibration Lead/GLAMR)

➤ UNIVERSITY GRANTS/GOV'T COLABORATORS

- Rochester Institute of Technology-Leads
 - Matt Montanaro (TIRS-2 and CVT)
 - Aaron Gerace (vicarious cal and Level 2 Val)
- University of Arizona - Leads
 - Stuart Biggar (Ball OLI-2)
 - Jeff Czaplá-Myers (Vicarious cal and Level 2 Val)
- South Dakota State University- Leads
 - Larry Leigh * (Vicarious cal and Level 2 Val)
 - Dennis Helder **
- NASA/JPL-Lead
 - Simon Hook (Vicarious cal and Level 2 Val)

- Cal/val team has been operating together on Landsats 8 and 9 for >15 years and will continue in like fashion moving forward.
- NASA Phase E (Science & Data Analysis) provides NASA support for ongoing Cal/Val and communications/outreach.

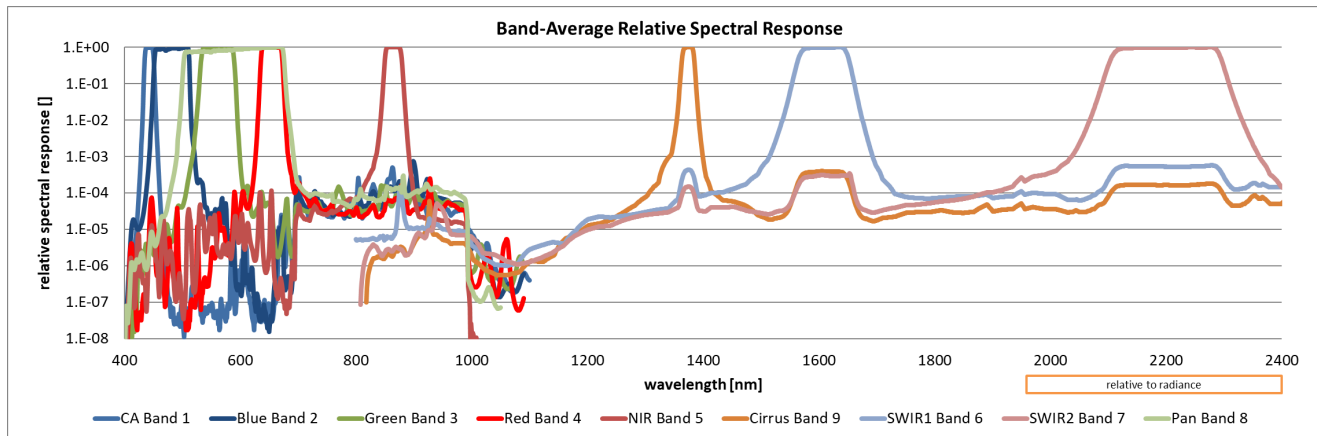
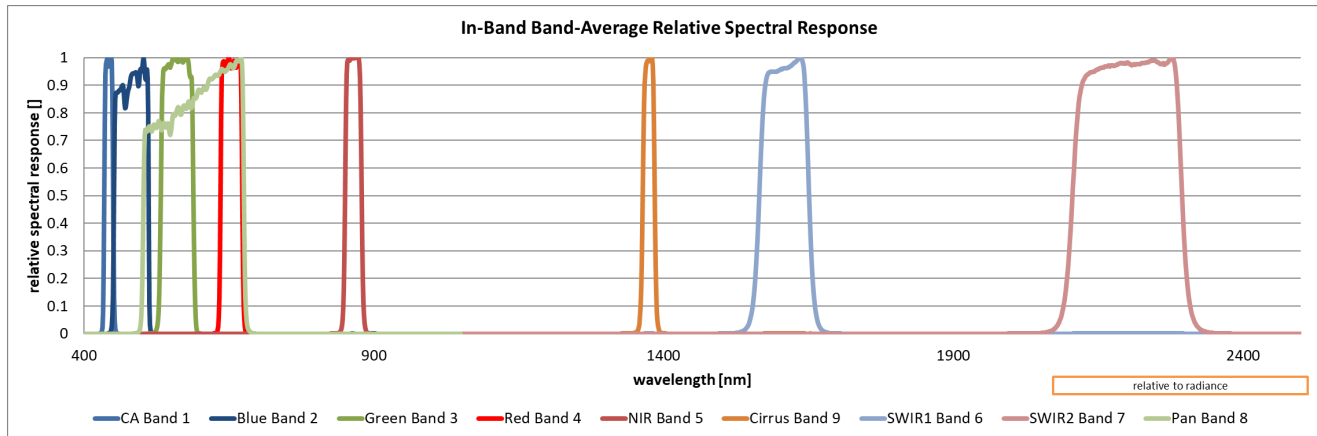


Landsat 9 Pre-launch, Commissioning, and Early On-Orbit Imaging Performance

Barsi, J. A.; Donley, E.; Goldman, M.; Kampe, T.; Markham, B. L.; McAndrew, B.; McCorkel, J.; Morland, E.; Pedelty, J. A.; Pharr, J.; Rodriguez, M. R.; Shuman, T. M.; Stutheit, C.; Sushkov, A. B. Prelaunch Spectral Characterization of the Operational Land Imager-2. *Remote Sensing* **2024**, *16* (6), 981.

<https://doi.org/10.3390/rs16060981>.

11 Mar 2024



GLAMR at Ball Aerospace with three OLAF tables located in a room adjacent to the TVAC chamber with OLI-2. GLAMR is a system of tunable lasers that cover 350–2500 nm which are fiber-coupled to a 30 in integrating sphere permanently monitored by NIST-traceable radiometers. GLAMR allowed the spectral characterization of every detector (70,000) of the OLI-2 focal plane in nominal imaging conditions.

Landsat 7 Calibration and Validation

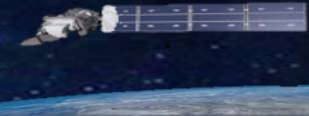



Fig. 90 Landsat 7 Collection 2 surface reflectance trends for the Libya 4 PICS

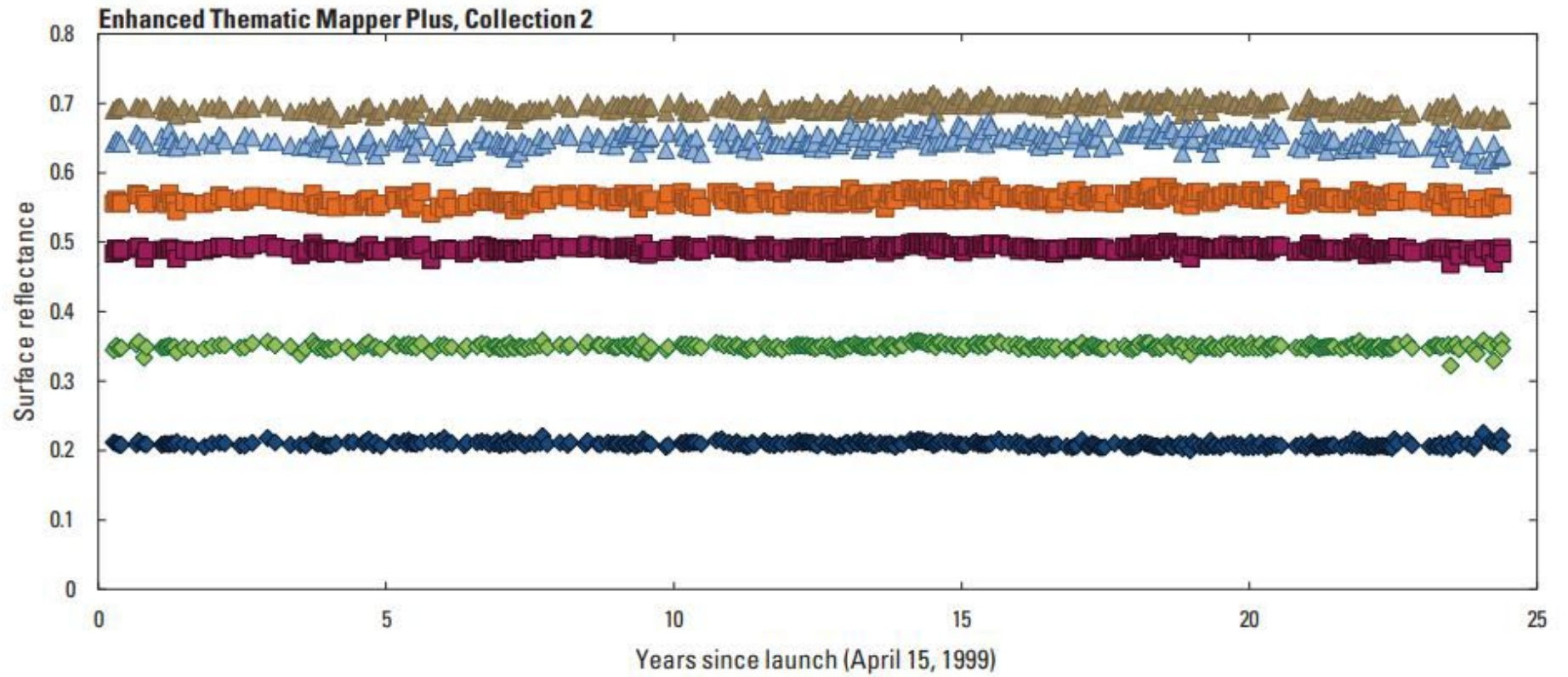
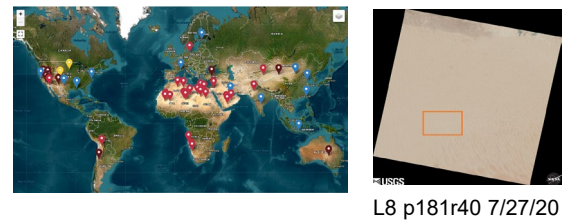


ECCOE Landsat Quarterly Calibration and Validation Report—Quarter 3, 2023

Open-File Report 2024-1017

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

<https://doi.org/10.3133/ofr20241017>
<https://pubs.usgs.gov/>



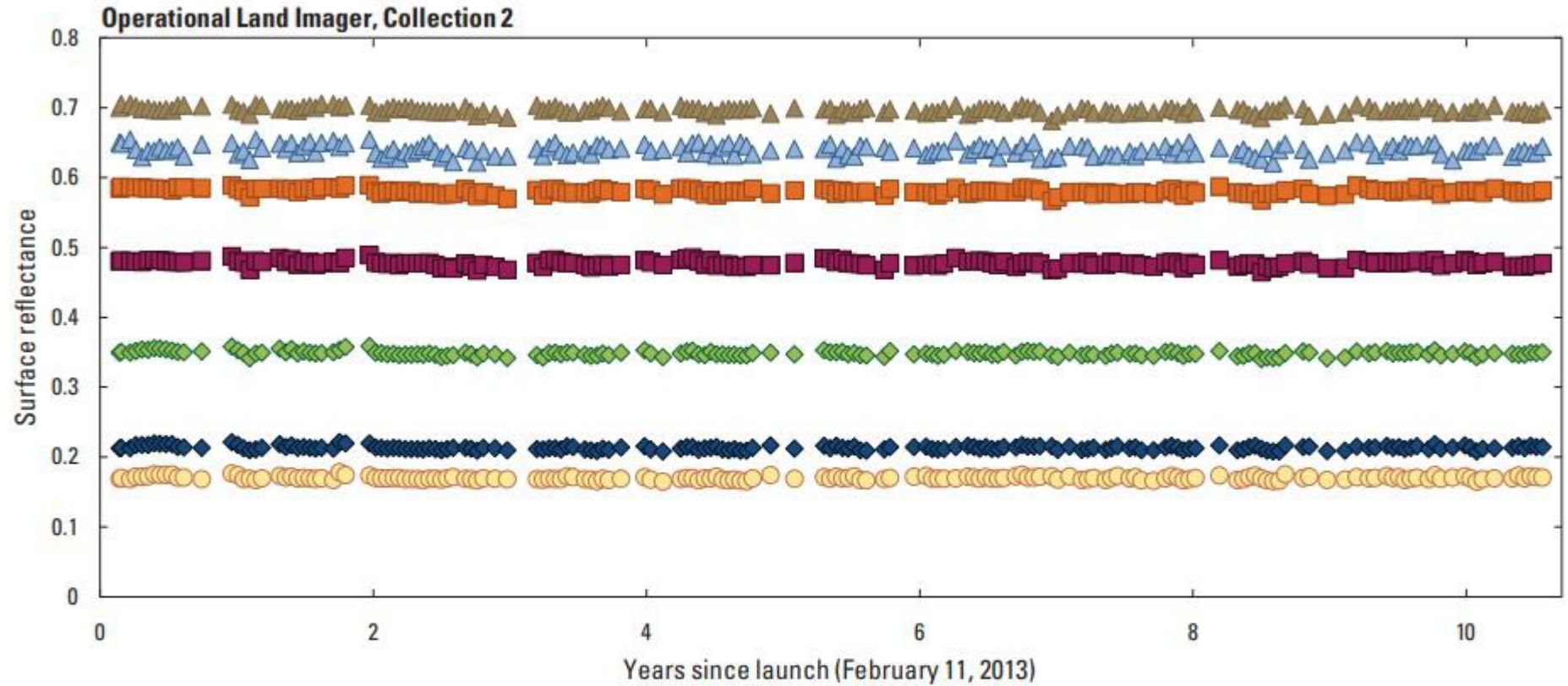
EXPLANATION

- Spectral band (drift per year, in percent)**
- ◆ Blue (-0.063)
 - Red (0.001)
 - ▲ Shortwave infrared 1 (0.028)
 - ◆ Green (0.003)
 - Near infrared (0.047)
 - ▲ Shortwave infrared 2 (0.022)

Landsat 8 Calibration and Validation



Fig. 91 Landsat 8 Collection 2 surface reflectance trends for the Libya 4 PICS



EXPLANATION

Spectral band (drift per year, in percent)

- ◆ Blue (-0.060)
- ◆ Green (-0.078)
- ◆ Red (-0.059)
- ◆ Near infrared (-0.060)
- ▲ Shortwave infrared 1 (-0.060)
- ▲ Shortwave infrared 2 (-0.045)
- Coastal/aerosol (-0.030)

science for a changing world

ECCOE Landsat Quarterly Calibration and Validation Report—Quarter 3, 2023

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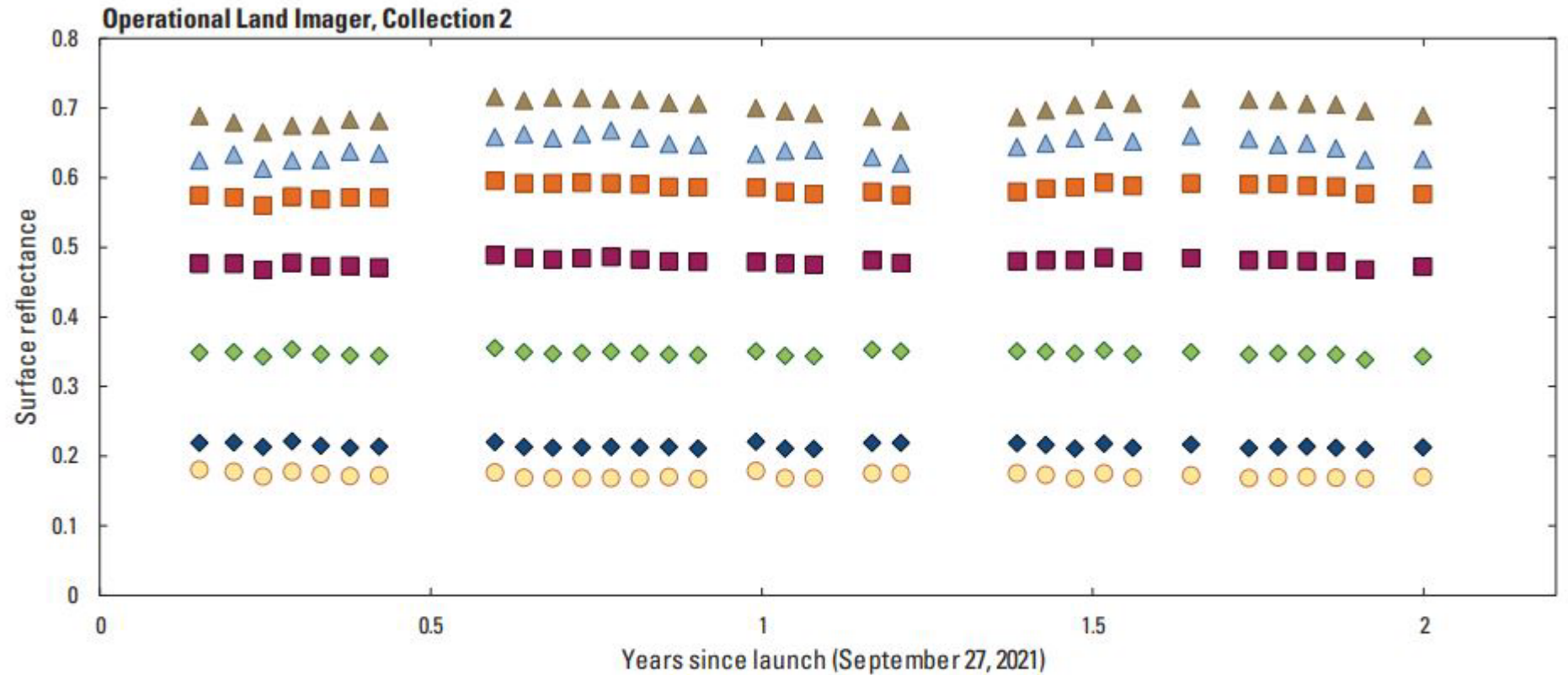


L8 p181r40 7/27/20

Landsat 9 Calibration and Validation

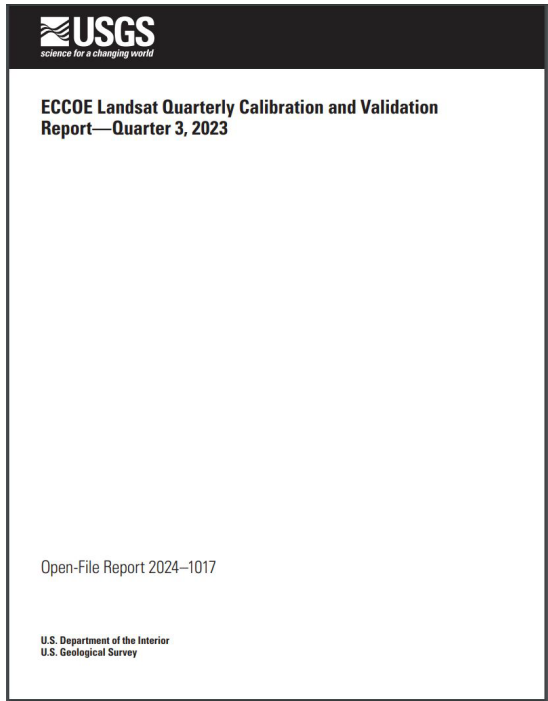


Fig. 92 Landsat 9 Collection 2 surface reflectance trends for the Libya 4 PICS



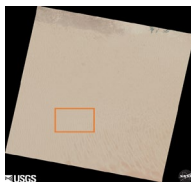
EXPLANATION

- Spectral band (drift per year, in percent)**
- ◆ Blue
 - ◆ Red
 - ▲ Shortwave infrared 1
 - Coastal/aerosol
 - ◆ Green
 - Near infrared
 - ▲ Shortwave infrared 2



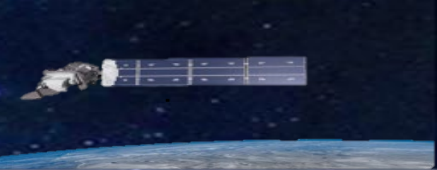
<https://doi.org/10.3133/ofr20241017>

<https://pubs.usgs.gov/>



L8 p181r40 7/27/20

Summary / Conclusion



- **All systems are nominal for L8 and L9, L7 is reaching end of life.**
- **Landsat 9 radiometric and geometric performance is excellent from a Cal/Val perspective.**
 - ❑ Spacecraft, ground system, and instruments continue to improve on L8 capabilities
 - ❑ Imagery looks great and performance exceeds requirements and, in many cases, by a significant margin
 - ❑ >1,400 images per day are collected by L8 and L9, the highest rate to date
- **On-orbit characterization of OLI-2 and TIRS-2 radiometric and geometric performance has confirmed and demonstrated that the all evaluated requirements are being met.**
- **Opportunities exist to share your high-profile Landsat based research through our communications team!**
- **Cal/Val Team continues for the duration of the mission as joint USGS/NASA effort.**
 - ❑ Will continue to monitor performance, characterize and update calibration parameters and algorithms as required to improve data products
 - ❑ Short term radiometry will be to continue evaluating on-orbit calibration data sets for trending information
 - ❑ Short term geometry efforts will be continued evaluation of geolocation accuracy and OLI-2 and TIRS-2 registration

<https://landsat.gsfc.nasa.gov/>

<https://www.usgs.gov/core-science-systems/nli/landsat>

<https://earthexplorer.usgs.gov/>