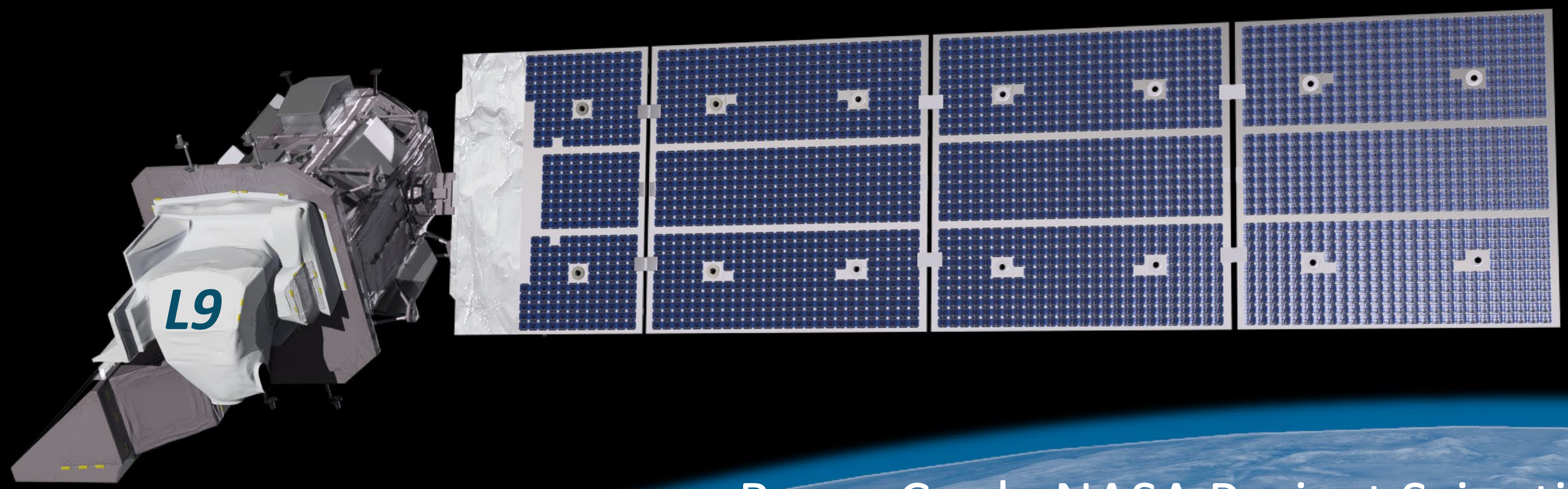
Landsat Next

Extending the Program of Record with a NEW Constellation Architecture and 2-3x the temporal, spatial, and spectral resolution!



Bruce Cook, NASA Project Scientist
Thomas Holmes, NASA Deputy Project Scientist
Goddard Space Flight Center, Greenbelt, MD

Chris Crawford, USGS Project Scientist
USGS Earth Resources Observation and Science (EROS) Center, SD

Landsat Next

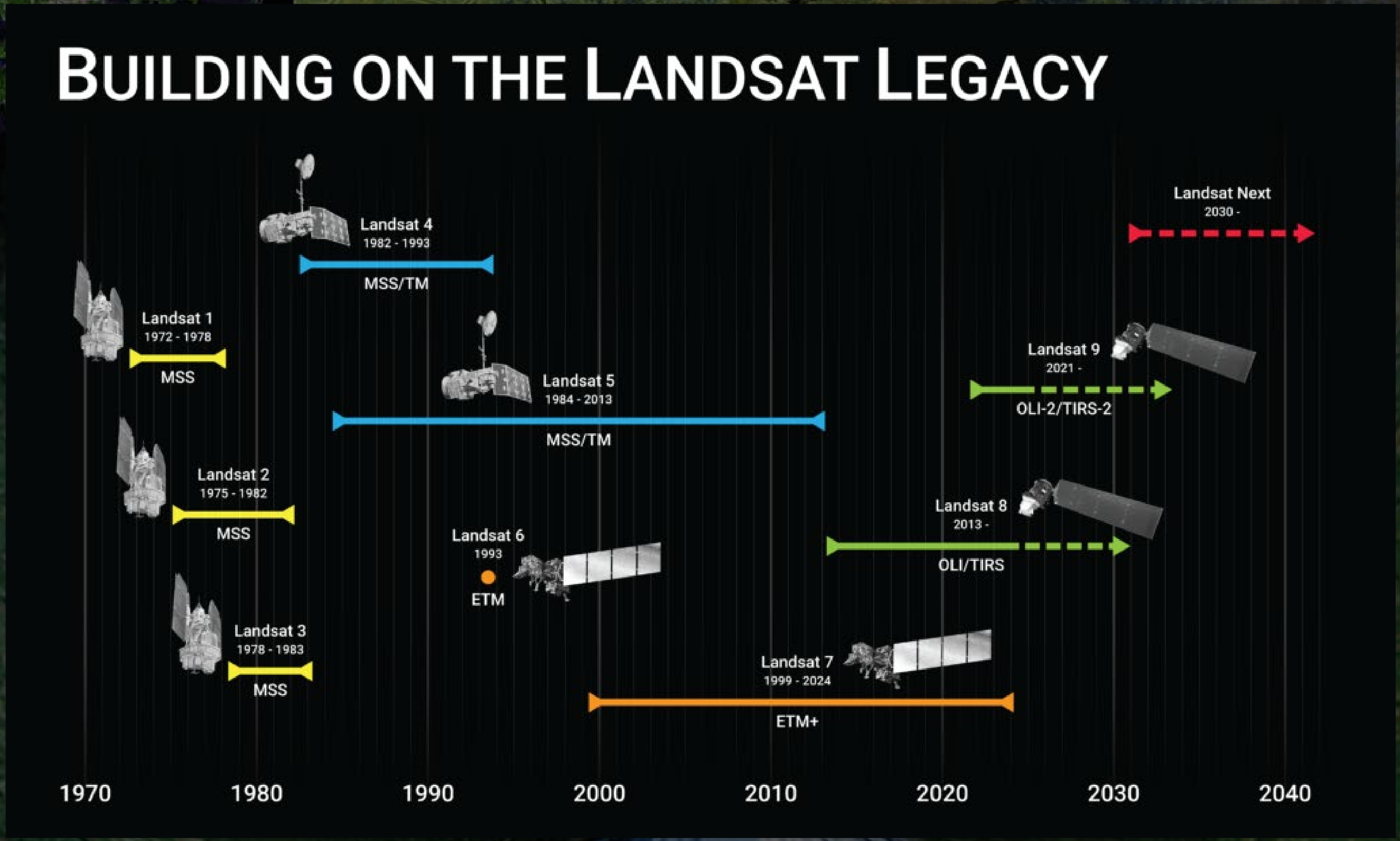
Development under the Sustainable Land Imaging (SLI) Program

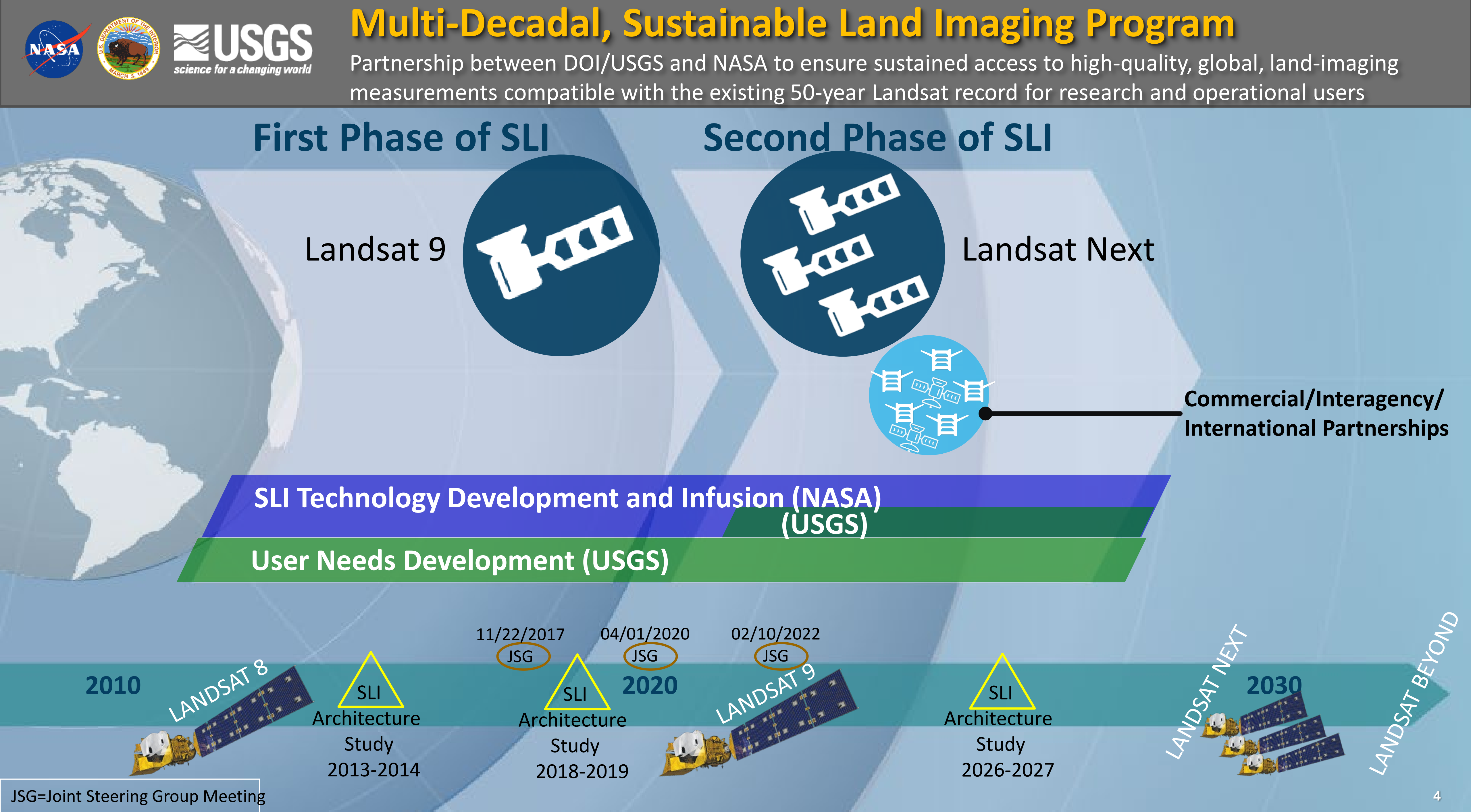
U.S. Government Pre-decisional – For Internal Government Use Only

Landsat and the Sustainable Land Imaging Program (SLI)

The SLI partnership between DOI/USGS and NASA ensures sustained access to high-quality, global, land-imaging measurements compatible with the existing 50-year Landsat record for research and operational users.

- NASA responsible for developing the space segment, launch and on-orbit check-out
- DOI/USGS responsible for developing the ground segment, flight and ground system operations

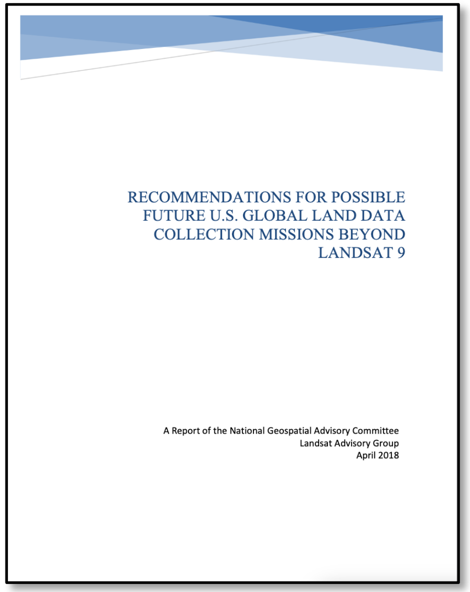


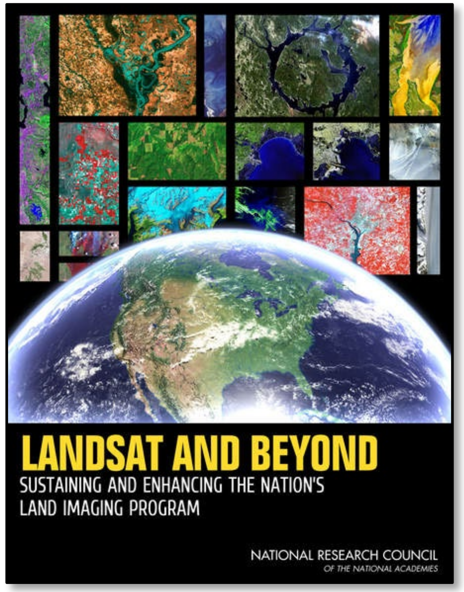

Multi-Decadal, Sustainable Land Imaging Program
Partnership between DOI/USGS and NASA to ensure sustained access to high-quality, global, land-imaging measurements compatible with the existing 50-year Landsat record for research and operational users
NASA
USGS
science for a changing world
First Phase of SLI
Second Phase of SLI
Landsat 9
Landsat Next
Commercial/Interagency/
International Partnerships
SLI Technology Development and Infusion (NASA)
(USGS)
User Needs Development (USGS)
2010
LANDSAT 8
SLI
Architecture
Study
2013-2014
11/22/2017
JSG
SLI
Architecture
Study
2018-2019
04/01/2020
JSG
2020
02/10/2022
JSG
LANDSAT 9
SLI
Architecture
Study
2026-2027
LANDSAT NEXT
2030
LANDSAT BEYOND
JSG=Joint Steering Group Meeting

Origin of Mission Science Requirements

Landsat Next Requirements reflect user priorities for land monitoring, as reflected in key documents

- USGS User Needs Survey of Federal Agencies (Wu et al., 2019)
- USGS Landsat Advisory Group (LAG) “Recommendations for Possible Future US Global Land Data Collection Missions Beyond Landsat 9” (2018)
- National Research Council “Landsat and Beyond” (2013)
- Recommendations from the NASA/USGS Landsat Science Team
- Feedback from Landsat Next Request for Information (RFI, Fall 2020)





Landsat Science Team, 2023

Requirements Meet Emerging Science Needs

User need surveys provided a clear set of priorities to meet emerging needs and achieve breakthrough science:

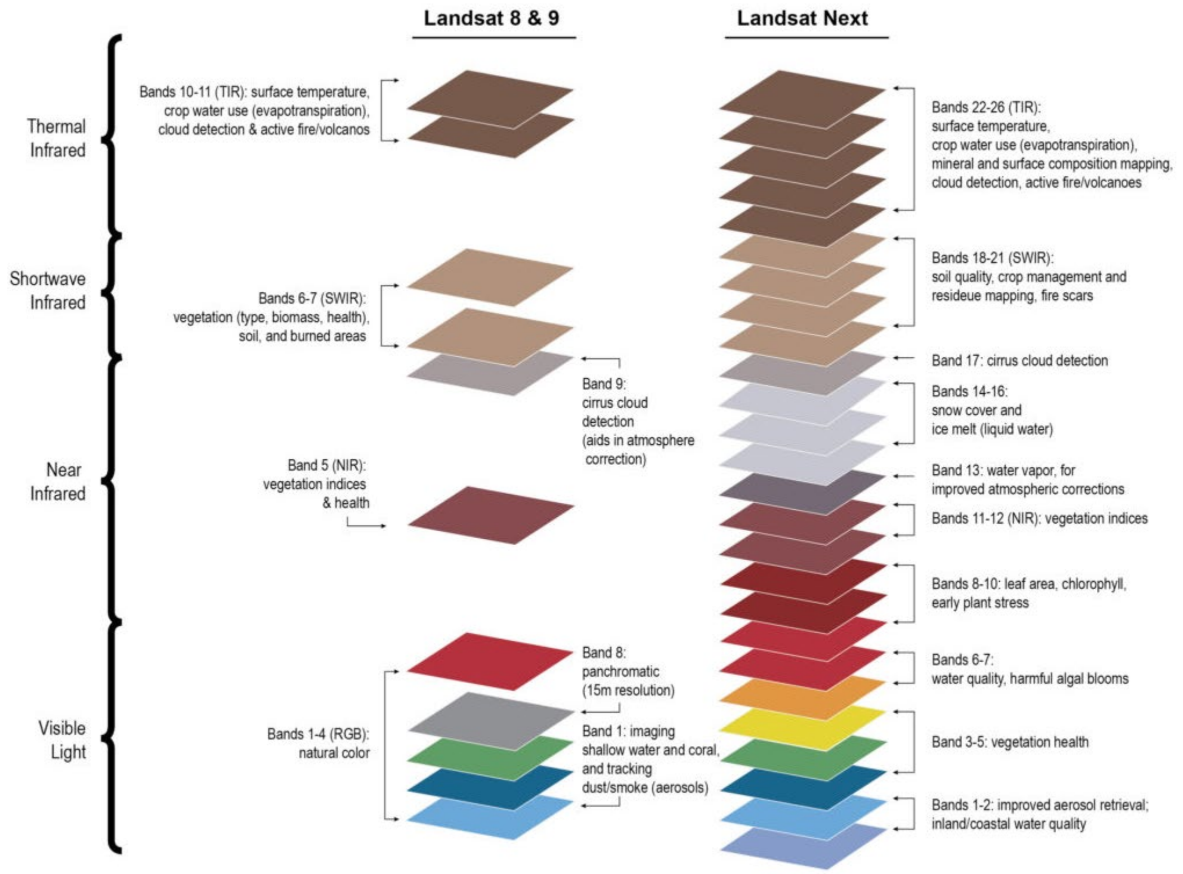
Improved Revisit Frequency. Dynamic phenomena (e.g., crop health & productivity, water quality, snow/ice state, wildfire) require ~weekly clear views.

Higher Spatial Resolution. Experience with Sentinel-2 has underscored importance of 10-meter data for monitoring small agricultural fields, forest disturbance, urbanization, and other observable features.

Additional spectral bands. Specific VSWIR and TIR bands support emerging applications in water quality, snow/ice dynamics, agricultural and soil management, and geological classification.

Maintaining radiometric quality established by Landsat 8/9

Multispectral -> Superspectral

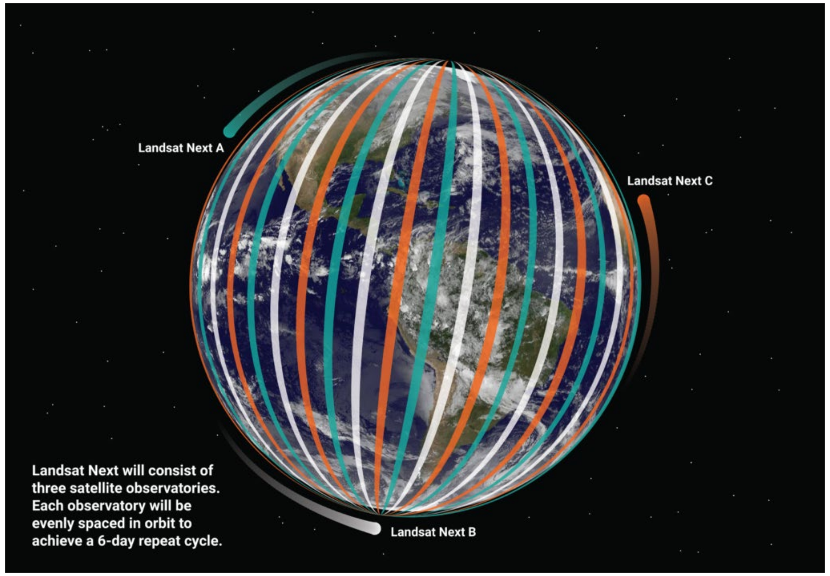


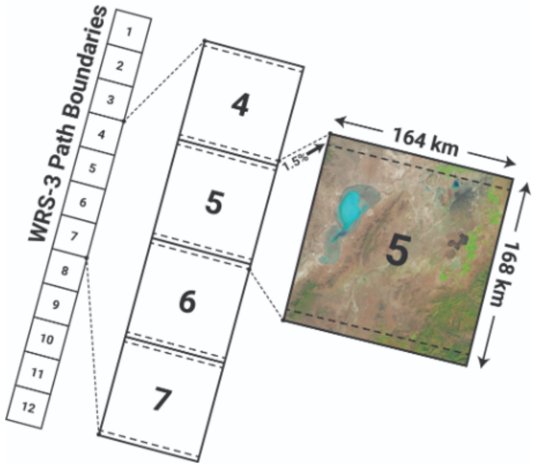
Landsat Next will provide more than twice as many spectral bands, with resolution improved by a factor of 2, and with the repeat coverage of Landsats 8 and 9, *combined*

Landsat Next

Mission Overview and Current Status

Landsat Next – Mission Overview





A new Worldwide Reference System, WRS-3, was developed for Landsat Next due to the change in orbital parameters. The WRS-3 will provide a method to acquire, index, and catalog Landsat Next scenes. Image credit: NASA Landsat Communications and Public Engagement Team.

WRS-3 PARAMETER	VALUE
Equatorial Altitude	653 km
Inclination	97.9835 degrees
Mean Local Time (Descending Node)	10:10 am ± 5 minutes
Number of Paths	265
Number of Rows	248
Repeat Cycle	18 days
Descending Node Row	60
Longitude of Path 001, Row 060	-65.2 degrees (65.2 W)
Swath Width	164 km
Along-Track Scene Length	168 km
Scene Size	164 km x 168 km

- Identical triplet satellites with VSWIR+TIR instrument suite, temporally disaggregated to improve revisit
- New Worldwide Reference System (WRS-3) developed for lower orbit (653 km) and reduced swath (164 km)
- Satisfies emerging Landsat user needs with maximum resiliency (6 d with 3 observatories, 9 d with 2 observatories)
- Complies with Landsat heritage science requirements

LANDSAT NEXT

QUICK FACTS

- Mission architecture: Identical triplet satellite observatories
- Mission Category: 2
- Mission Class: B
- Number of spectral bands: 26
- Spatial resolution: 10-20 meters (VSWIR), 60 meters (atmospheric/TIR)
- Orbit: Sun-synchronous at 653 km (406 miles)
- Orbital inclination: 98 degrees
- Observatory orbital separation: 120 Degrees
- Mean equatorial crossing time: 10:10 am ± 5 minutes
- Single observatory repeat interval: 18 days
- Triplet constellation repeat interval: 6 days
- Global cataloging grid system: WRS-3
- Scene size: 164 km (102 miles) x 168 km (104 miles)
- Half angle field of view: 7.2 degrees
- Expected launch date: Late 2030
- Mission design life: 5 years

GODDARD EARTH SCIENCES

LNext
Landsat Next

LNext Science Requirements: Spectral, Spatial

	Band Name	Ground Sample Distance (m)	Center wavelength (nm)	Band width (nm)	Rationale
1	Violet	60	412	20	Improved aerosol retrieval; CDOM from inland/coastal water
2	Coastal Aerosol	20	443	20	Landsat
3	Blue	10	490	65	Landsat
4	Green	10	560	35	Landsat
5	Yellow	20	600	30	Leaf chlorosis, vegetation stress and mapping
6	Orange	20	620	20	Phycocyanin detection for Harmful Algal Blooms
7	Red 1	20	650	20	Phycocyanin, chlorophyll
8	Red 2	10	665	30	Landsat
9	Red Edge 1	20	705	15	LAI, Chlorophyll, plant stress (S2)
10	Red Edge 2	20	740	15	LAI, Chlorophyll, plant stress(S2)
11	NIR_Broad	10	842	115	10m NDVI (S2)
12	NIR1	20	865	20	Continuity (note-S2 narrower than L8)
13	Water vapor	60	945	20	Improved atmospheric correction for LST, SR (S2)
14	Liquid Water	20	985	20	Liquid water, water surface state
15	Snow/Ice 1	20	1035	20	Snow grain size for water resources
16	Snow/Ice 2	20	1090	20	Ice absorption, snow grain size
17	Cirrus	60	1375	30	Landsat
18	SWIR 1	10	1610	90	Landsat
19	SWIR 2a	20	2038	25	Subdivided for cellulose/crop residue measurement (Landsat)
20	SWIR 2b	20	2108	40	Subdivided for cellulose/crop residue measurement (Landsat)
21	SWIR 2c	20	2211	40	Subdivided for cellulose/crop residue measurement (Landsat)
22	TIR 1	60	8300	250	Mineral and surface composition mapping (ASTER)
23	TIR 2	60	8600	350	Emissivity separation, volcanos (SO2) (MODIS/ASTER)
24	TIR 3	60	9100	350	Mineral and surface composition mapping (ASTER)
25	TIR 4	60	11300	550	Surface temperature (Landsat), carbonates
26	TIR 5	60	12000	550	Surface temperature, snow grain size (Landsat)

Landsat Next's
NEW Capabilities!

Fine-Res (10m) VSWIR

Vegetation attributes

Atmospheric correction

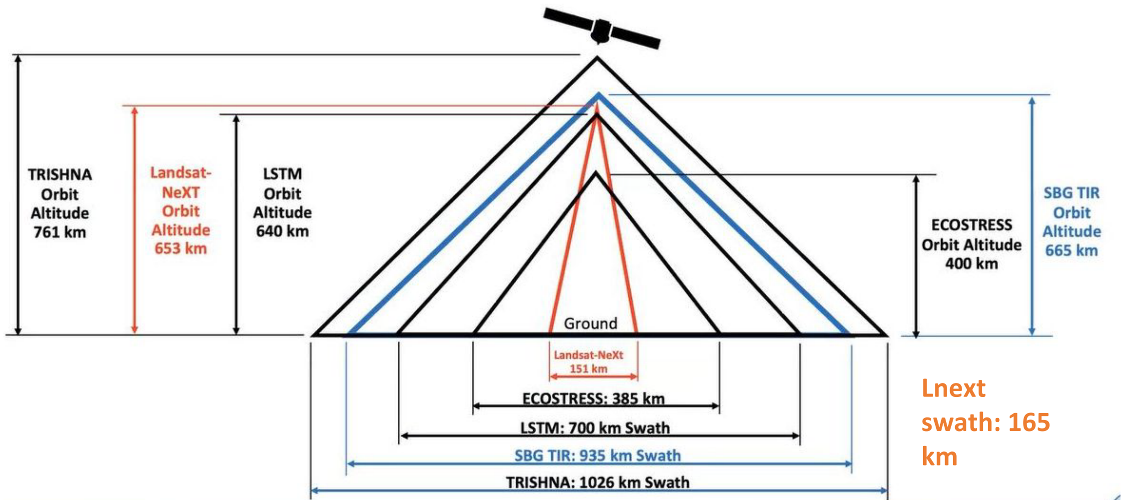
Water Quality / Algae

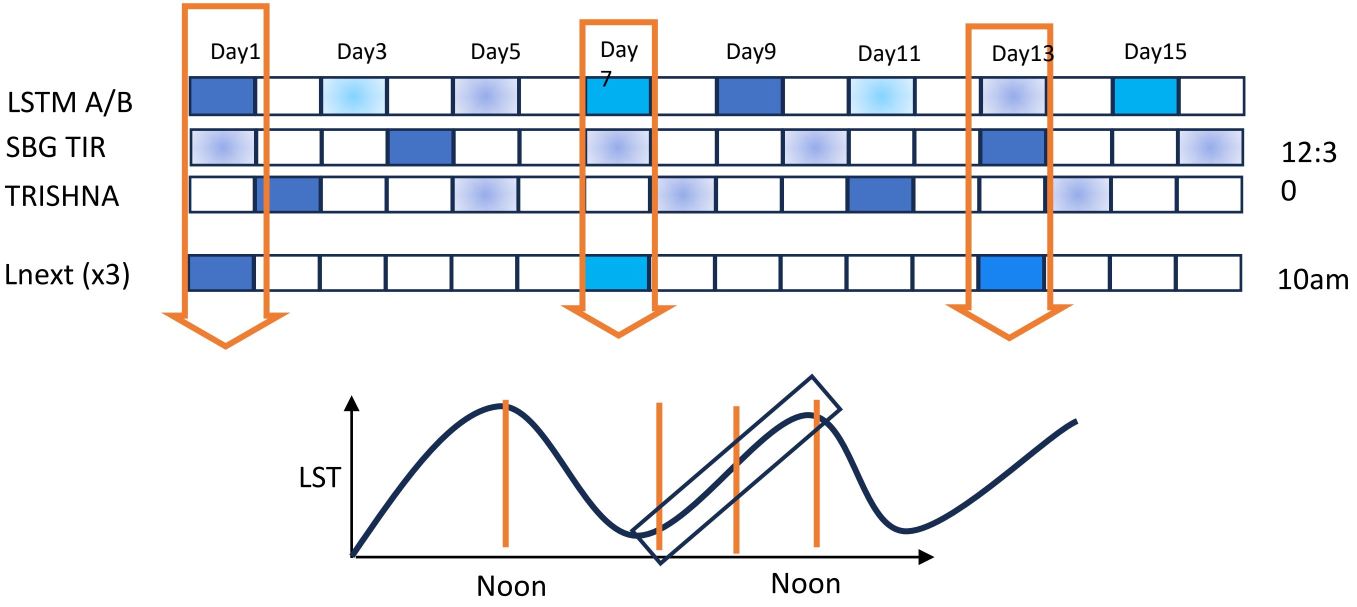
Snow/Ice Dynamics

Mineral Mapping

Virtual Constellation of Diurnal TIR Measurements

- When the LSTM constellation is in place, each 10am Landsat observation (L8, L9 and LNext) will have a matching mid-day observation
- About half of these matches will be with Nadir +-10 degrees observations
- With Landsat-Next, ALL these TIR observations will have
  - 60 m GSD or better
  - 4 or more thermal bands





GODDARD EARTH SCIENCES

Current and Future Work

Mission Architecture concept definition is complete, and **Landsat Next is officially in Phase A!**

Pre-Phase A - user surveys; architectural studies to determine science mission requirements

Phase A – science flow down to hardware requirements; architecture credibility and refinement

Phase B – preliminary design and technology completion

Phase C – final design and fabrication

Phase D –system assembly, integration/testing, and launch readiness;

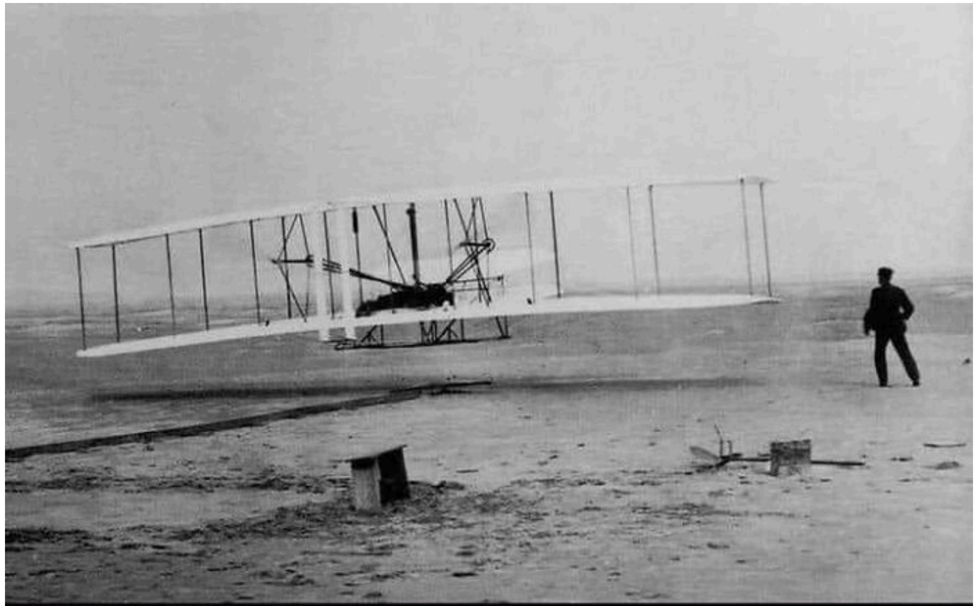
Phase E – starts after on-orbit operational checkout and ends at the mission's operational end.

Ongoing Phase A Work:

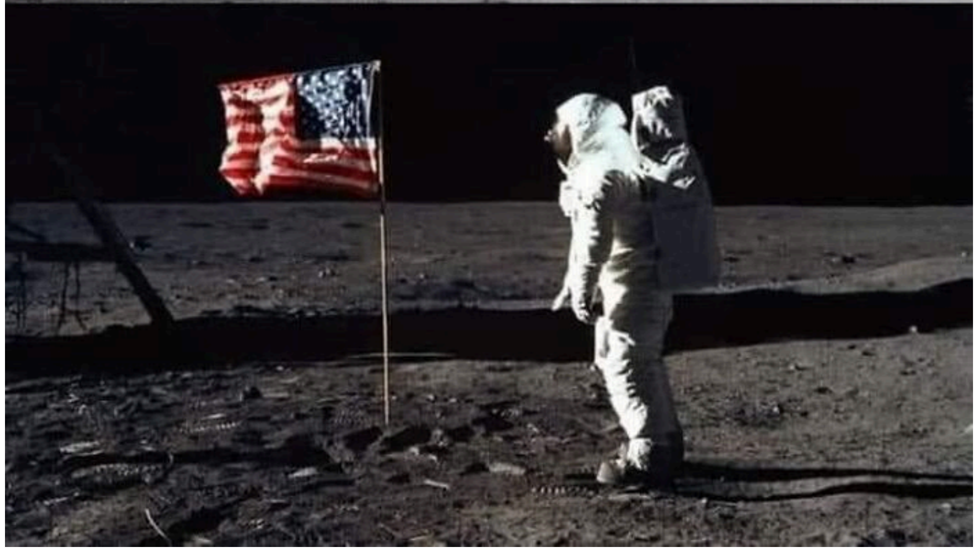
- **Landsat Next Instrument Suite (LandIS)** is on the Mission's critical path.
    - Proposals are being evaluated, and NASA expects to have a vendor on contract by summer 2024.
- **NASA Spacecraft** Request for Proposals (RFP) is planned to be distributed during Fall 2024, and the project expects to have a vedor on contract by summer 2025.
- **USGS Ground System studies** to assess ground stations, data compression, constellation mission operations.

There are 60-70 Years Between These Pictures

First airplane flight
Wright Flier
December1903



First Lunar Landing
Apollo 11
20 June 1969



First Landsat
ERTS-A / Landsat 1
Launched 23 July 1972

Breakthrough science opportunities coming soon!

Tenth Landsat
Landsat Next
LRD Late-2030 (+58 years)

Backup

Must See Videos – Current Landsat Mission Status

Landsat 8/9

[Landsat 2023: A Year in Review]

[ExtraDimensional - The Fusion of Landsat & GEDI Data]

Landsat Next

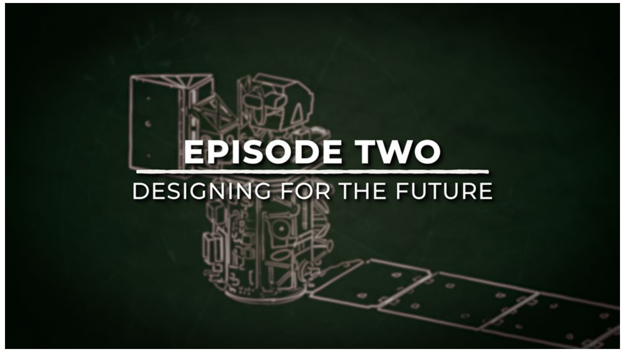
[Landsat's Next Chapter]

[Landsat Next Defined]

Must See Videos – Landsat's 50+ Year History

Continuing the Legacy Series

[E01: Getting Off the Ground]



[E02: Designing for the Future]

[E03: More than Just a Pretty Picture]

[E04: Plays Well With Others]

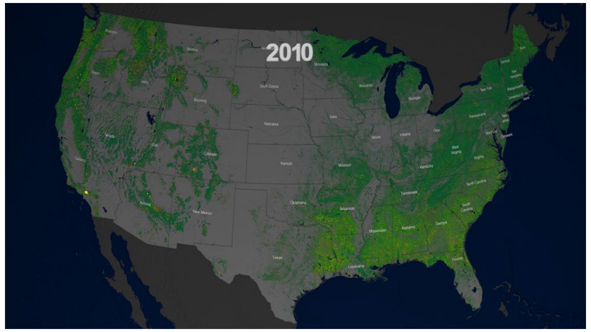
A Trip Through Time with Landsat 9

Landsat 8: A Decade of Service

Virginia Norwood and
the Little Scanner that Could

Must See Videos – Selected Landsat Applications

[Landsat's Role in Monitoring Water Quality]



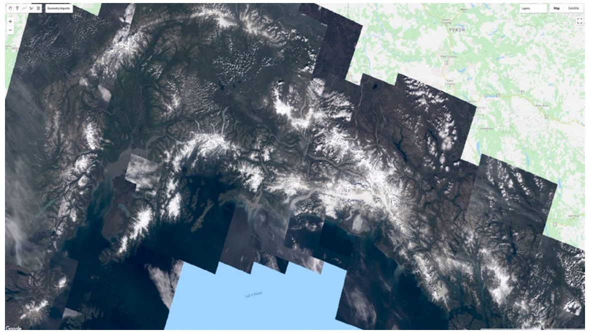
[Landsat Croplands Data Overview]

[Tracking Amazon Deforestation]

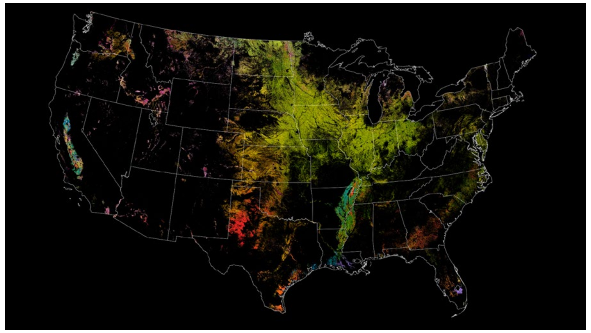
[Tracking Three Decades of Dramatic Glacial Lake Growth]

[Landsat: Farming Data from Space]

[Mapping Ecosystems to Understand Their Value]



[48 Years of Alaska Glaciers]



[25 Years of Forest Dynamics]

[NASA Joins Jane Goodall to Conserve Chimp Habitats]

LANDSAT APPLICATIONS (L8)

https://landsat.gsfc.nasa.gov

FIRE

Burning Wildlands and a Burning Need for Landsat

LAND USE AND LAND COVER CHANGE

Effective Tools for Cleaning our Waterways

WATER

Mapping Water Use

FOOD

Monitoring Crops from Space: A Decades-Long Partnership

ECOSYSTEMS

Mapping the Western Pine Beetle

FORESTS

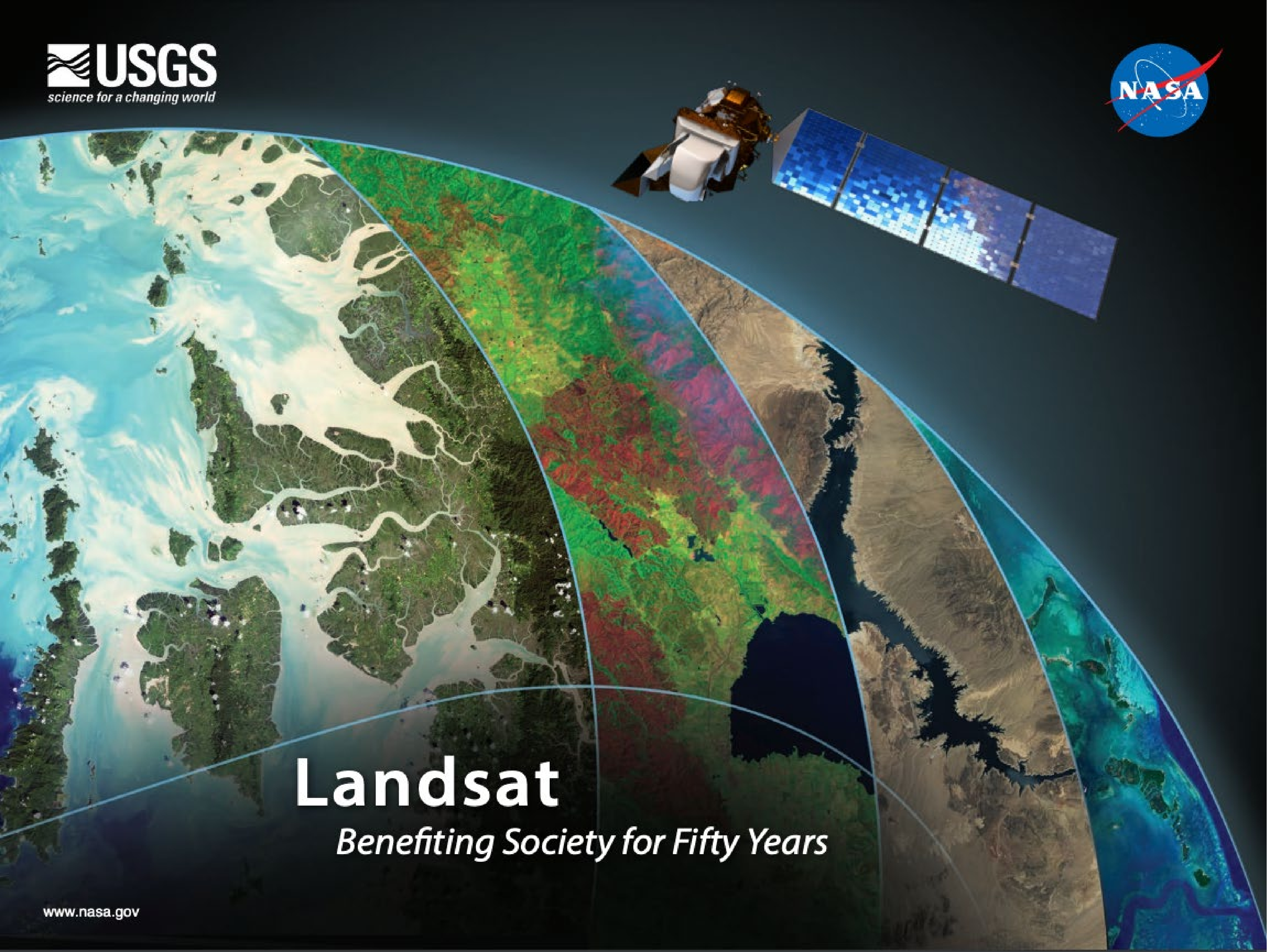
Counting the World’s Trees

DISASTERS

Mapping Disaster: A Global Community Helps from Space

BATHYMETRY

Avoiding Rock Bottom: How Landsat Aids Nautical Charting



LANDSAT APPLICATIONS (L9)

https://landsat.gsfc.nasa.gov

FOREST MANAGEMENT
Spotting Deforestation with Landsat

BATHYMETRY
Avoiding Rock Bottom: How Landsat Aids Nautical Charting

AGRICULTURE
Addressing the Water Consumption Riddle

WATER
Satellites on Toxic Algae Patrol

CLIMATE
Landsat Provides Global View of Speed of Ice

FIRE
After the Fire: Landsat Helps Map the Way Forward