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science for a changing world

50+ Years of Landsat Satellite Earth Observations
What Landsat means for Western States

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Summary Up Front

USGS Core Science Systems – National Land Imaging Program

- The multi-decadal Landsat Earth Observation Satellite program remains heavily used across the nation and around the world with annual economic benefit of $25B
- USGS and NASA co-manage new mission development under Sustainable Land Imaging (SLI); NASA develops satellites to meet USGS user needs; USGS develops the ground system, operates the on-orbit satellites, and generates and disseminates data and products
- The future mission, once called Landsat Next and involving three "triplet" satellites, was revamped in the FY27 President's Budget Request to a single government satellite, Landsat 10, with a parallel pivot to commercial systems. Congress continues to support a 3-satellite solution, though the FY27 Budget is uncertain
- Landsat supports a host of applications important to WSWC; Landsat 10 will deliver even more capability

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What is Landsat?

- **The world's longest continuously operated land remote sensing satellite series**
- **The most widely used and cited land remote sensing data set**
- **Critical to understanding land, water, and natural resources**
- **An indispensable tool to understand and effectively manage landscape change**



Common uses of Landsat data by Federal Agencies, States, and the private sector:

- Agriculture and Forestry
- Regional Land Use Planning
- Land Use/Land Cover
- Fire/Disaster Management
- Energy and Mineral Mapping
- Water Quality and Resources
- Global Change Science
- Flood Management
- National Security
- Ecosystem Monitoring
- Famine Early Warning
- Carbon Assessment
- Drought Monitoring
- Transportation Planning
- Calibration/Validation

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Multi-spectral coverage in VNIR-SWIR-TIR**
- » to map surface composition & temperature

15 / 30 / 100 meter spatial resolution
- » to resolve human-scale land dynamics

16-day revisit frequency (8-days w/ two satellites)
- » global, seasonal coverage

Broad area collection ≥ 12,000+ square miles per image
- » 1500 images/day = 20 million square miles/day

Highly calibrated "science quality" data
- » to resolve long-term trends
- » to improve commercial satellite data & applications

Free and Open Data policy since 2008
- » Billions of data and product accesses annually, vastly accelerating landscape science and improving related public and private services

***VNIR: Visible Near-Infrared SWIR: Shortwave Infrared TIR: Thermal Infrared*

The Legacy

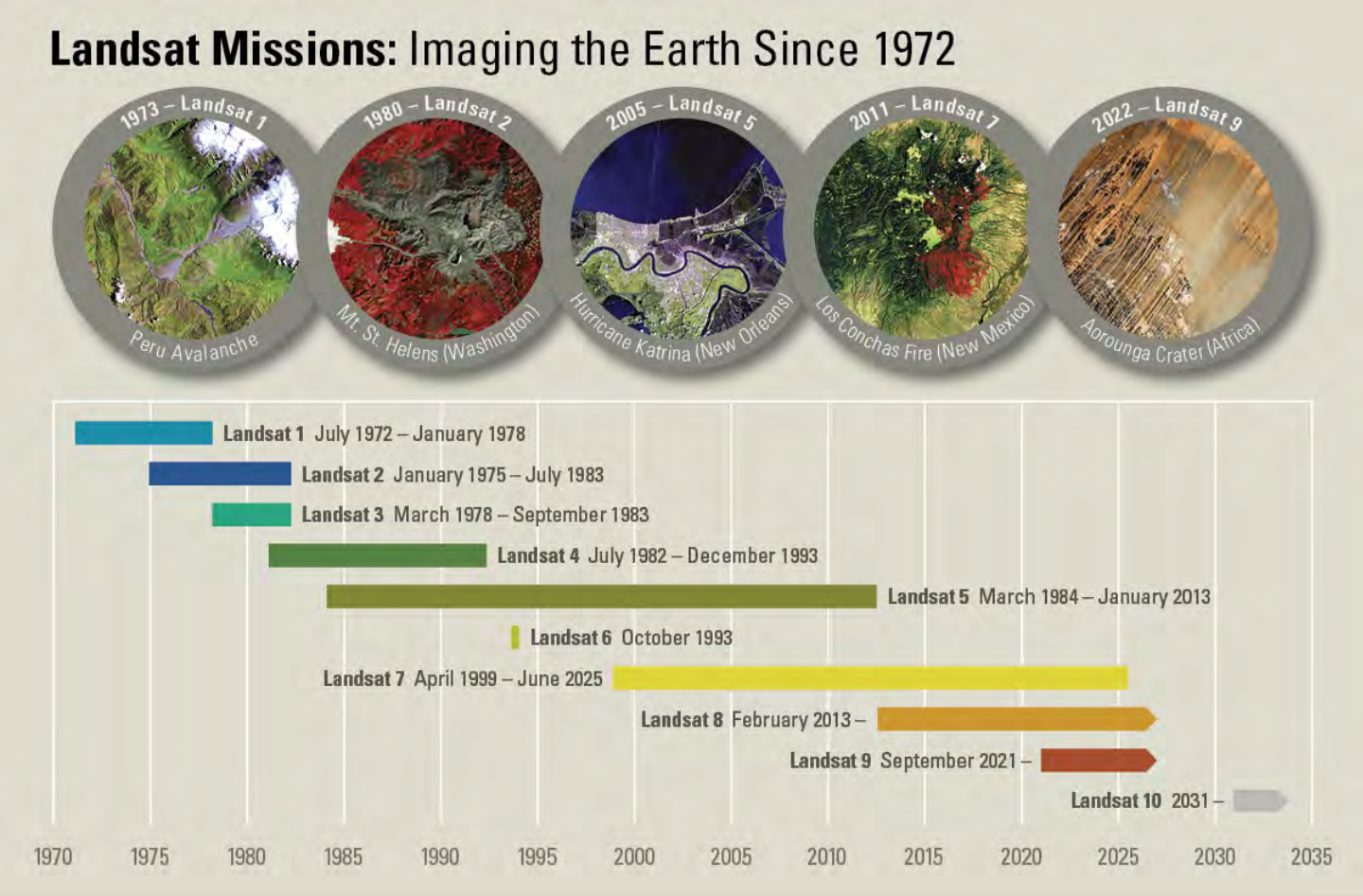
The Longest Continuous Record of Earth From Space

54
years of continuous data

10M+
scenes in the open archive

1.1M+
publications

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$25B
Annual Economic Benefit of Free and Open Data Policy

1TB
Landsat data downlinked daily to EROS

NASA USGS

Sustainable Land Imaging Partnership

Continuing the Legacy

America 250 Commemorative Landsat Poster

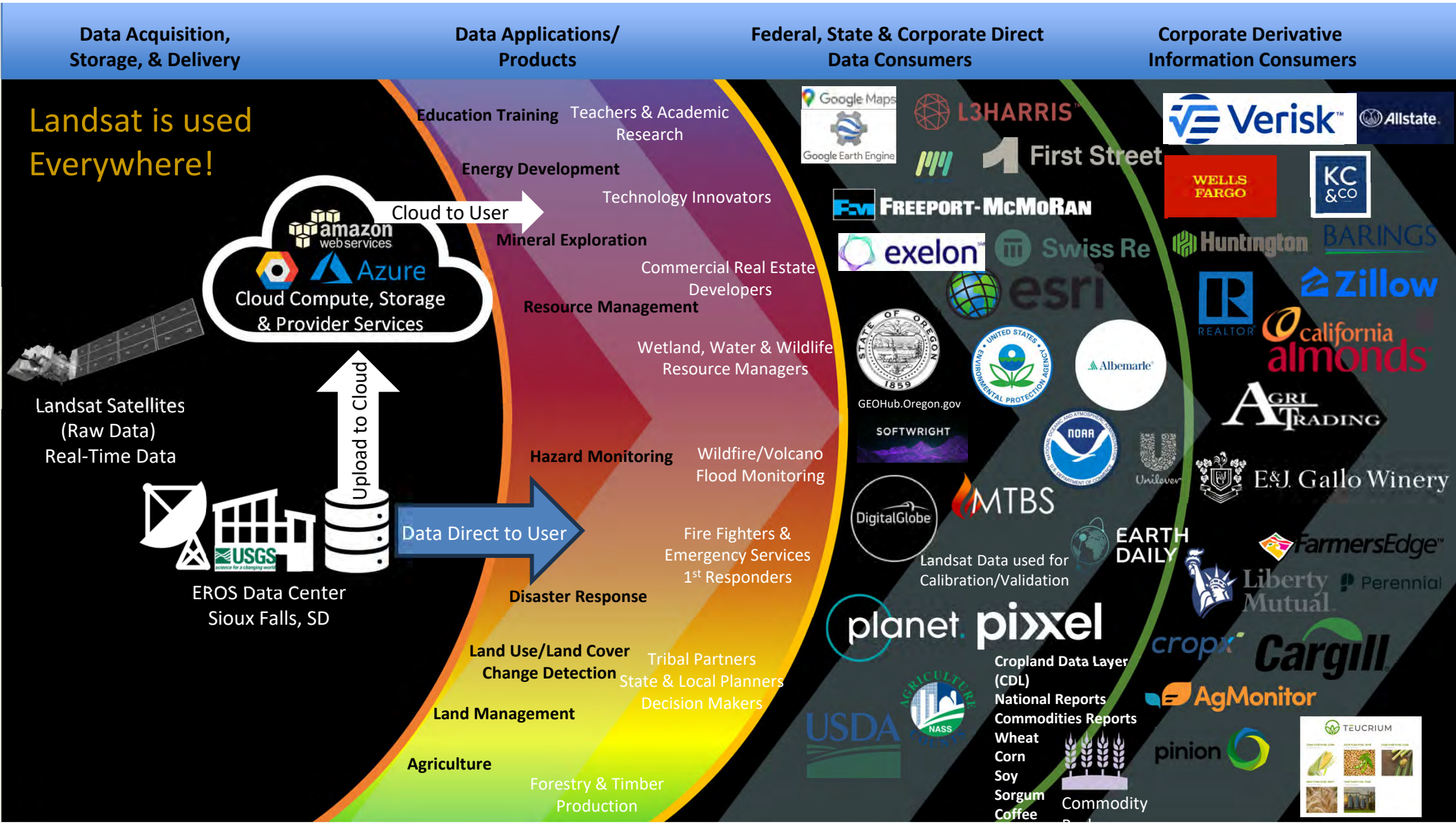




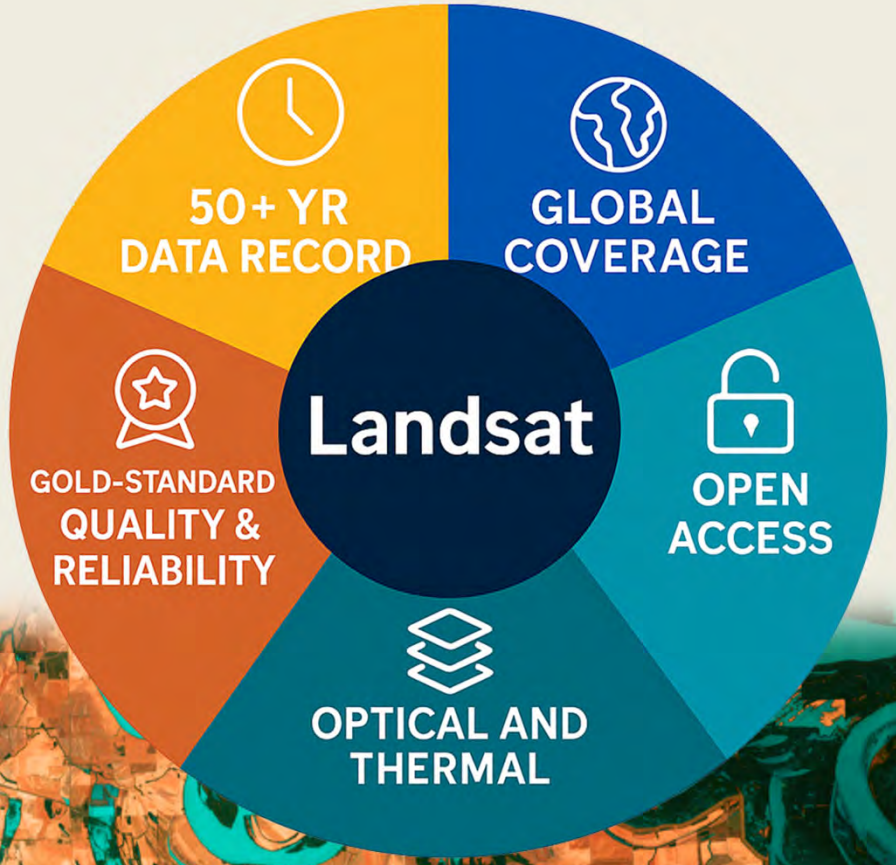
July 1976

July 2026

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Data Acquisition, Storage, & Delivery
Data Applications/ Products
Federal, State & Corporate Direct Data Consumers
Corporate Derivative Information Consumers
Landsat is used Everywhere!
Cloud to User
amazon web services
Azure
Cloud Compute, Storage & Provider Services
Upload to Cloud
Landsat Satellites (Raw Data) Real-Time Data
USGS
EROS Data Center Sioux Falls, SD
Data Direct to User
Education Training
Teachers & Academic Research
Energy Development
Technology Innovators
Mineral Exploration
Commercial Real Estate Developers
Resource Management
Wetland, Water & Wildlife Resource Managers
Hazard Monitoring
Wildfire/Volcano Flood Monitoring
Fire Fighters & Emergency Services 1st Responders
Disaster Response
Land Use/Land Cover Change Detection
Tribal Partners
State & Local Planners
Decision Makers
Land Management
Agriculture
Forestry & Timber Production
Google Maps
Google Earth Engine
L3HARRIS
First Street
FREEPORT-McMoRan
exelon
Swiss Re
esri
GEOHub.Oregon.gov
SOFTWRIGHT
Albemarle
NOAA
Unilever
DigitalGlobe
MTBS
Landsat Data used for Calibration/Validation
EARTH DAILY
planet.
pixxel
USDA
NASS
Cropland Data Layer (CDL)
National Reports
Commodities Reports
Wheat
Corn
Soy
Sorgum
Coffee
Commodity
Verisk
Allstate.
WELLS FARGO
KC &CO
Huntington
BARINGS
Zillow
REALTOR
california almonds
AGRI TRADING
E&J Gallo Winery
FarmersEdge
Liberty Mutual
Perennial
cropx
Cargill
AgMonitor
pinion
TEUCRIUM

Why Users Choose Landsat



Unmatched Data Record: 50+ years of consistent, science-quality land imaging enabling long-term trend analysis and time-series monitoring

Global Systematic Coverage: Consistent worldwide acquisition supporting local, regional, national, and global environmental assessment

Free & Open Access: No-cost to user, open archive enabling a variety of data uses and broad innovation across research, public agencies, and the private sector

Optical + Thermal Capabilities: Simultaneous visible, near-infrared, shortwave-infrared, and thermal infrared measurements for surface composition, vegetation, water use, and temperature

Gold-Standard Calibration & Reliability: Highly calibrated measurements, long mission lifetimes, and trusted reference data for science and commercial satellite calibration

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Why Users Choose Landsat

"Landsat has provided **critical imaging of the planet** for over five decades.
– Jack Dangermond, **Esri**

"Landsat is the only operational satellite **having both thermal data and a spatial resolution fine enough** to map water-resources use at the level of agricultural fields."
- Tony Willardson, **Western States Water Council**

"Landsat is **paramount for GIS science research and teaching**…"
– Eric Shook, University of Minnesota

"**Landsat data are a key data source**…"
– **Verisk**

"**Timelapse in Google Earth is possible because of the commitment to open and accessible data** through NASA and the United States Geological Survey's Landsat program…."
– Chris Herwig, **Google Earth Engine**

"Landsat is **the single most valuable tool** that we have used."
– Nick Dokoozlian, **Gallo Research Group**

"Landsat can provide a significant value into our analysis on a **large-scale assessment** of our corporate lands…"
– Kevin Costello, **Exelon**

"The satellite data from Landsat are one of the **most important inputs** to the ET models…"
– **OpenET**

"Landsat imagery is valuable for **critical minerals** project development…"
– Alexi Zawadzki, **Lithium Americas**

"We are significant users of Landsat on a **daily basis**…"
– Joel Kimmelshue, **Land IQ**

"Our agricultural analytics business, among other services **relies daily on Landsat 8 and 9** data."
– Eric von Eckartsberg, **Earth Daily Analytics**

"USGS/NASA Landsat Next program offers significant **monetary and strategic value** for the U.S. autonomous vehicle (AV) industry …"
– Nirav Patel, **Applied Intuition**

"Landsat Next is not just an upgrade; it's **essential infrastructure** for the next generation of AI tools…"
– Devaki Raj, **Saab, Inc.**

"Landsat spectral GEOINT is **crucial in addressing key intelligence questions**."
– Frank D. Whitworth, **National System for Geospatial Intelligence**

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Ensuring Trusted Earth Intelligence Through Landsat Accuracy

What is it?

- **Geometric accuracy:** each pixel is in the right place on Earth.
- **Radiometric accuracy:** each pixel has the right value of reflected energy.

Together, they make Landsat a scientific measurement tool, not just a camera.

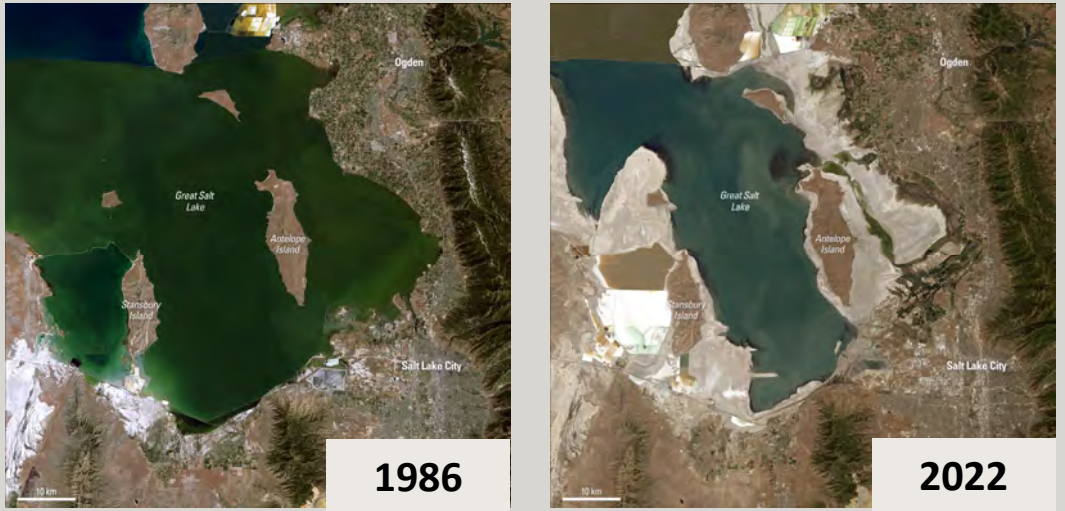
Why does it matter?

- **Reliable change detection:** differences over time (50+ years) are real, not sensor drift.
- **Cross-sensor compatibility:** consistency across the multiple Landsat missions and between Landsat and other missions.
- **Trusted decisions:** the underlying data is beyond question, allowing users to rely on the results in their applications.

In a 2020 Earth observation focused User Needs and Valuation Study by RTI International, **63% of respondents rated data quality as "extremely important,"** reflecting its critical role across applications such as agriculture and water resources, algal bloom and water-quality monitoring, fire ecology and risk assessment, and mineral resource management.

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Landsat Case Study: Great Salt Lake 1986-2022



- The Great Salt Lake has experienced dramatic shoreline retreat, exposing lakebed that threatens air quality, ecosystems, and regional water security.
- Landsat's high geometric accuracy and strict error tolerance ensure precise measurement of shoreline changes.
- Radiometric accuracy allows scientists to reliably track salinity, water extent, and dust-prone exposed lakebed over time.

The Value Proposition

Why this matters to Western states

Agriculture

Crop condition, irrigation, yield

Water Management

Consumptive use, drought, supply

Forestry

Forest health, harvest, inventory

Wildfire

Fuels, active fire, recovery

Land Use Planning

Growth, change, base layers

Disaster Response

Floods, storms, damage assessment



Agenda

01 **Program Status**
Where the constellation stands today

02 **Landsat ET Data & Products**
What's available and how it's packaged

03 **Case Studies**
Landsat evapotranspiration data uses today

04 **Getting Started**
Access points and getting started

05 **Key Takeaways & Resources**
Where to go next



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Program Status

Mission Updates

- **Landsat 8:** Collecting 750 new multispectral and thermal infrared scenes/day (with 11 distinct bands of data across over 10 million square miles).
- **Landsat 9:** Collecting 750 new scenes/day (more than 10 million square miles of new imagery).



Quick Facts Landsats 8 & 9

Temporal Revisit: 8 days (combined)
Spatial Resolution: 15-30 m VSWIR, 100 m TIR
Launch Date: Landsat 9 = 2021, Landsat 8 = 2013
Spectral bands: 11
Global reference grid system: WRS-2
Scene size: 185 km x 180 km



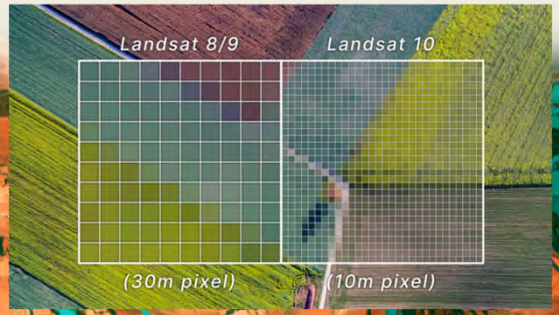
Program Status

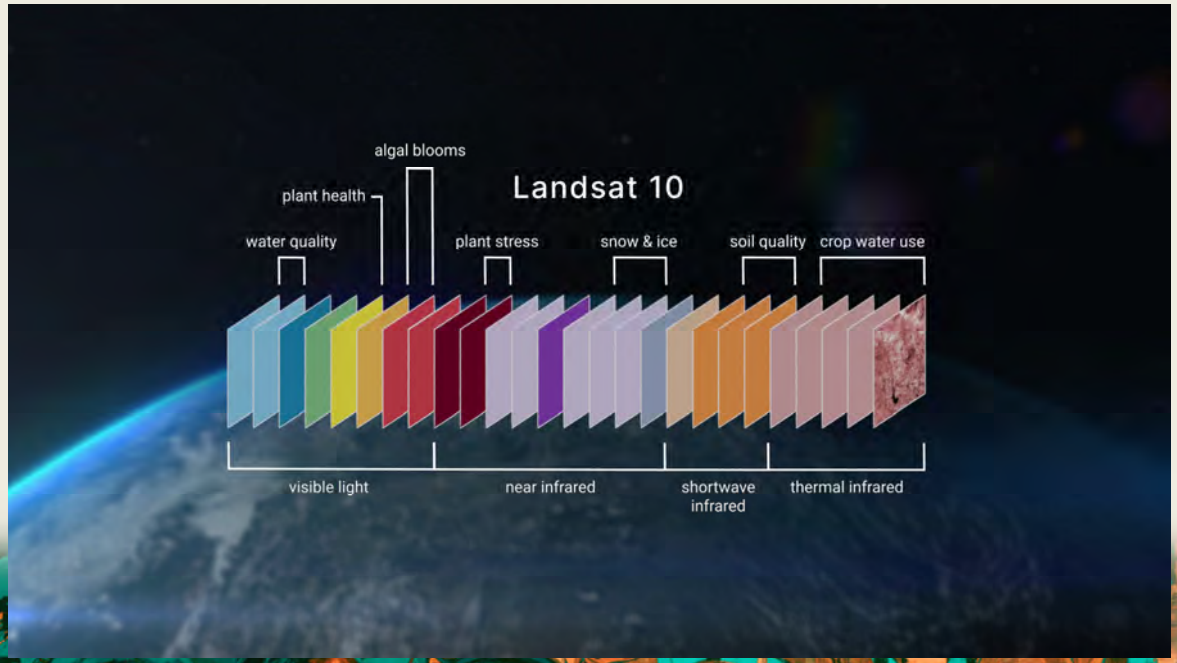
Looking Ahead: Landsat 10

Formerly known as "Landsat Next" — refined into a leaner mission, same commitment to free and open data.

26 spectral bands (up from 11 today)

2× improved spatial resolution



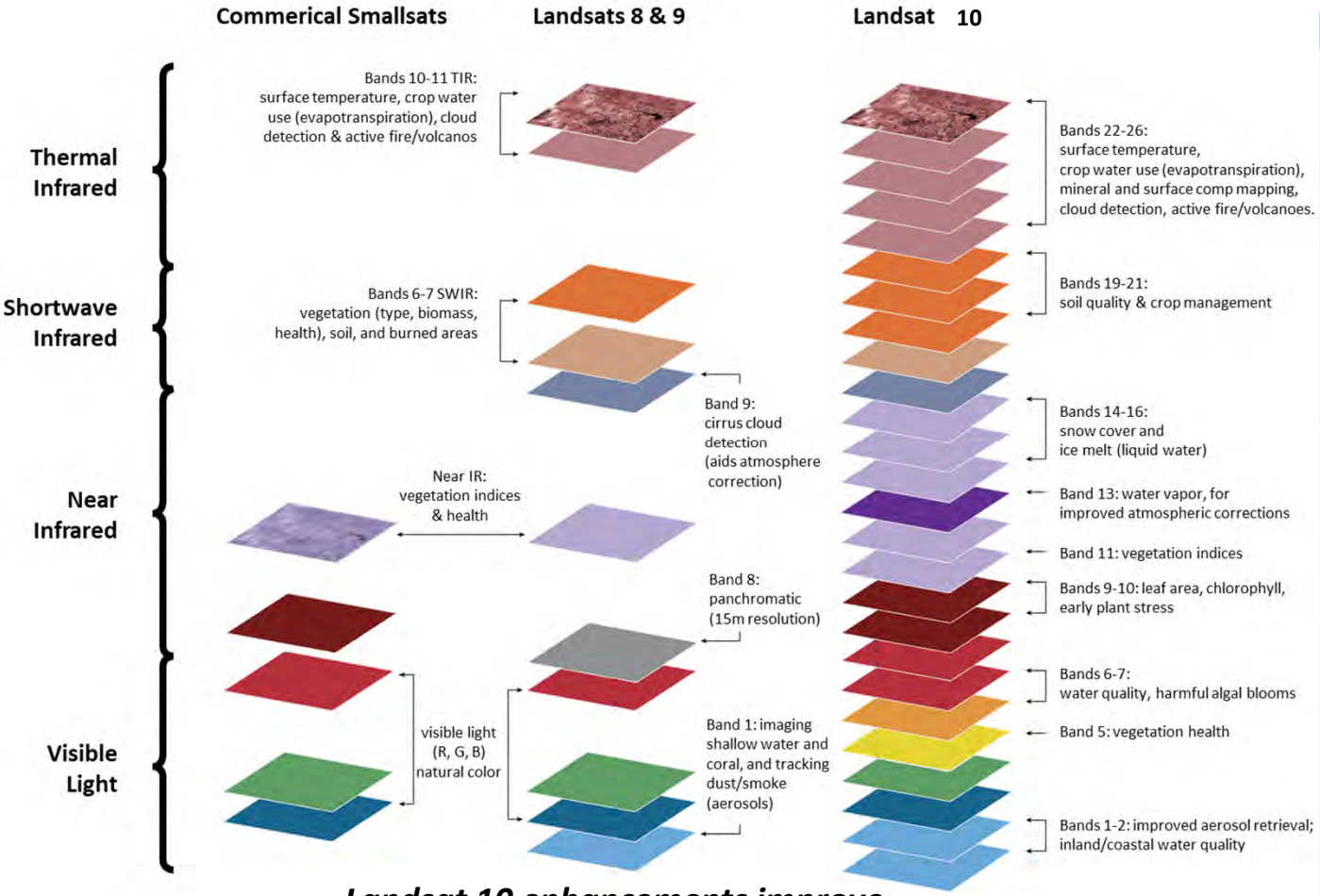


Quick Facts

Temporal Revisit: 18 days
Expected Launch: 2031
Spatial Resolution: 10-20 m VSWIR, 60 m TIR
Spectral bands: 26
Global reference grid system: WRS-3
Scene size: 164 km x 164 km

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Landsat 10 Comparison with Commercial, Landsat 8/9



Landsat 10 enhancements improve our understanding of global environmental change

Landsat 10 Science/Applications Benefit	Enhancement
Supports emerging applications: • Water quality & resources, including climate related stress and drought • Snow hydrology • Crop residue mapping & soil characterization and carbon sequestration • Mineral mapping • New environmental change science while providing continuity with past Landsat missions, and compatibility with the European Sentinel-2 mission	Acquires 26 spectral bands, more than twice the number acquired by Landsat 8/9
Supports field-scale crop type mapping, crop yield estimates, and crop water usage; improved urban thermal mapping and heat islands; early detection of forest disturbance and degradation from environmental change.	Improves spatial resolution to 10, 20, or 60 meters for all bands
Enables improved monitoring of within-season land and water dynamics • Highest priority of current Landsat users • Supports monitoring highly dynamic phenomena (water quality, fire, wetland inundation, land phenology) • Greater resilience to cloud contamination	Potentially improves the acquisition frequency to all land/coastal areas

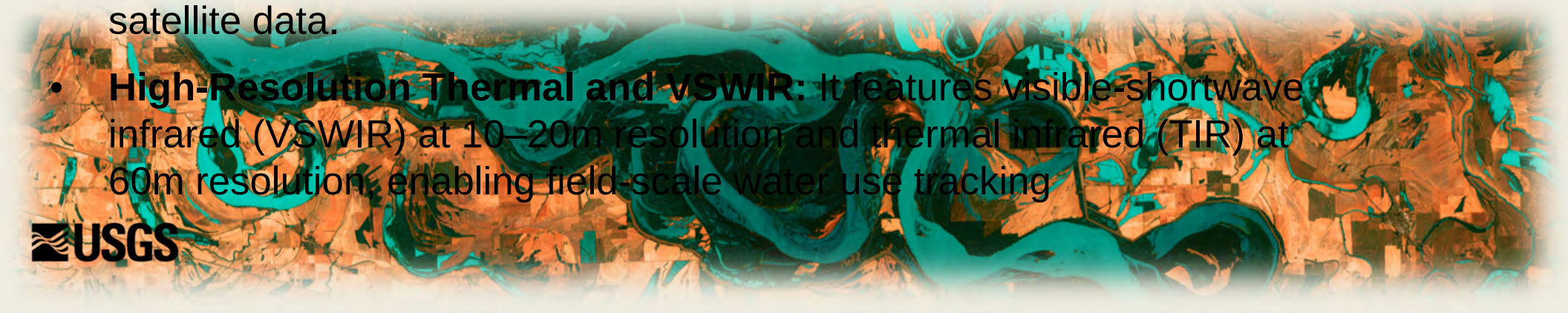
Program Status

Looking Ahead: Landsat 10

Landsat-based ET continuity through the 2030's

Key Features for Evapotranspiration on Landsat 10

- **Simultaneous Acquisition:** Landsat 10 acquires all 26 bands nearly simultaneously (within 15 seconds), which reduces illumination changes and improves the accuracy of surface reflectance and thermal emission products like ET.
- **Built-in Water Vapor Band:** It includes a dedicated water vapor band that allows for direct atmospheric correction without needing external satellite data.
- **High-Resolution Thermal and VSWIR:** It features visible-shortwave infrared (VSWIR) at 10–20m resolution and thermal infrared (TIR) at 60m resolution, enabling field-scale water use tracking



Sustainable Land Imaging (SLI) Commercialization Initiative
SLI Industry Week Overview - Summary Slide

Event held: Aug 31–Sep 3, 2026 at USGS HQ, Reston VA

Purpose:

- Announce SLI commercialization strategy and enable a sustained commercial role in Landsat
- *Strategy shift: Move to commercially enabled Landsat-compatible products*

Objective:

- Share NASA/USGS commercialization strategy and expand industry's sustained role in Landsat

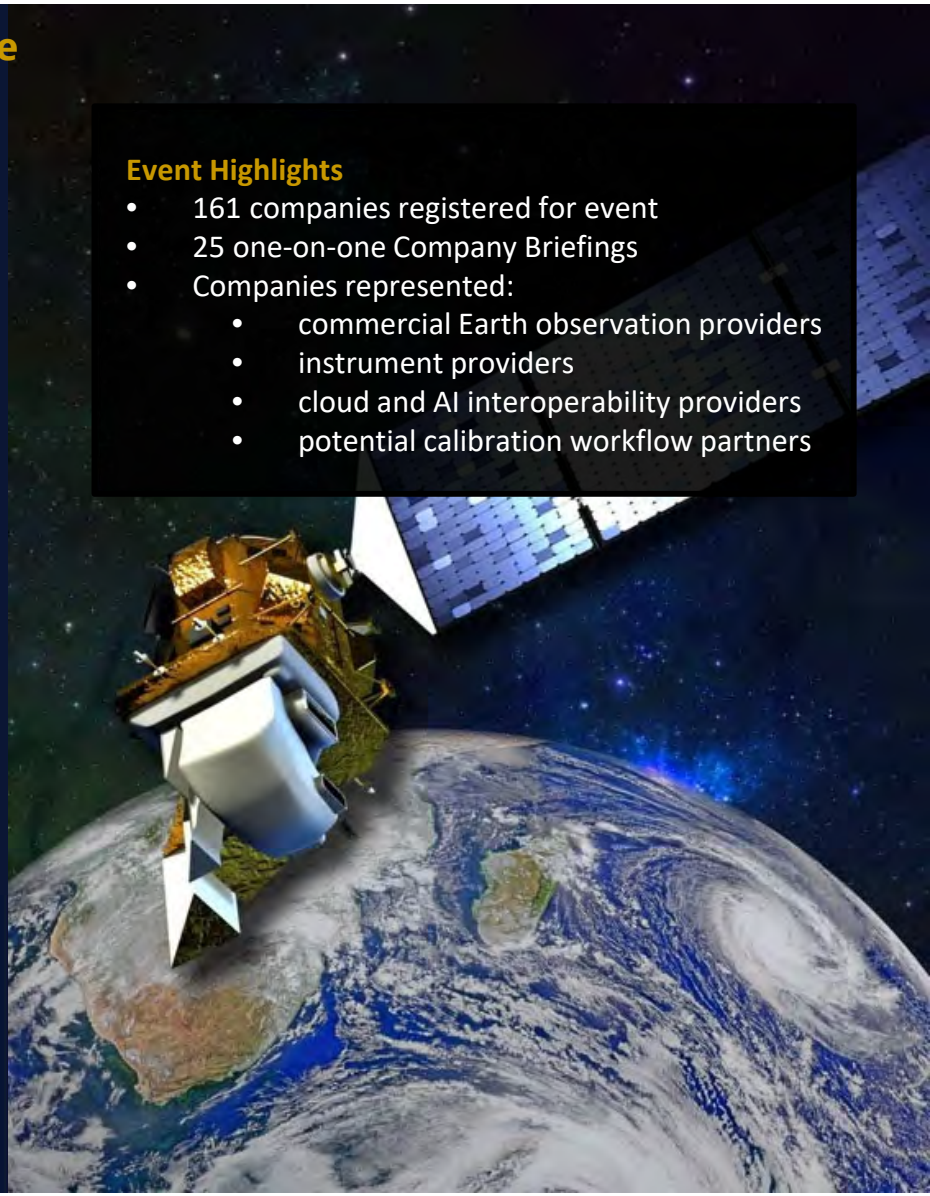
Approach:

- Product-based using commercial EO data, analytics, and Cal/Val to deliver Landsat-compatible products

Near term:

- FY27–FY28 demos; prototype workflow ingesting commercial L1; autonomous ground Cal/Val; phased product plan

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Landsat
&
Evapotranspiration

USGS



Landsat & Evapotranspiration 101

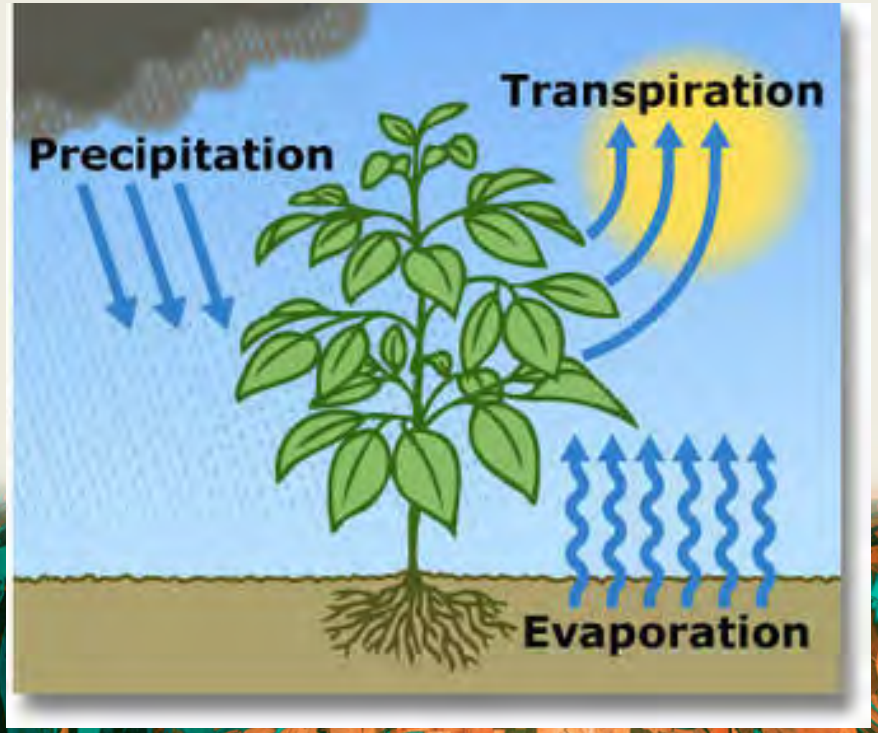
Evapotranspiration

What is evapotranspiration?

Evapotranspiration = Evaporation + Transpiration
As the sun heats the Earth's surface, water returns to the atmosphere in two ways:

1. Evaporation: Water evaporates from the soil, open water, and other surfaces.
2. Transpiration: Water is released as vapor from plants through tiny pores in their leaves and stems called stomata.

Think of ET as the reverse of precipitation. Instead of water falling from the sky, ET is water rising back into the atmosphere as vapor. Once there, it can travel long distances, condense, and eventually fall again as rain or snow—completing the water cycle.



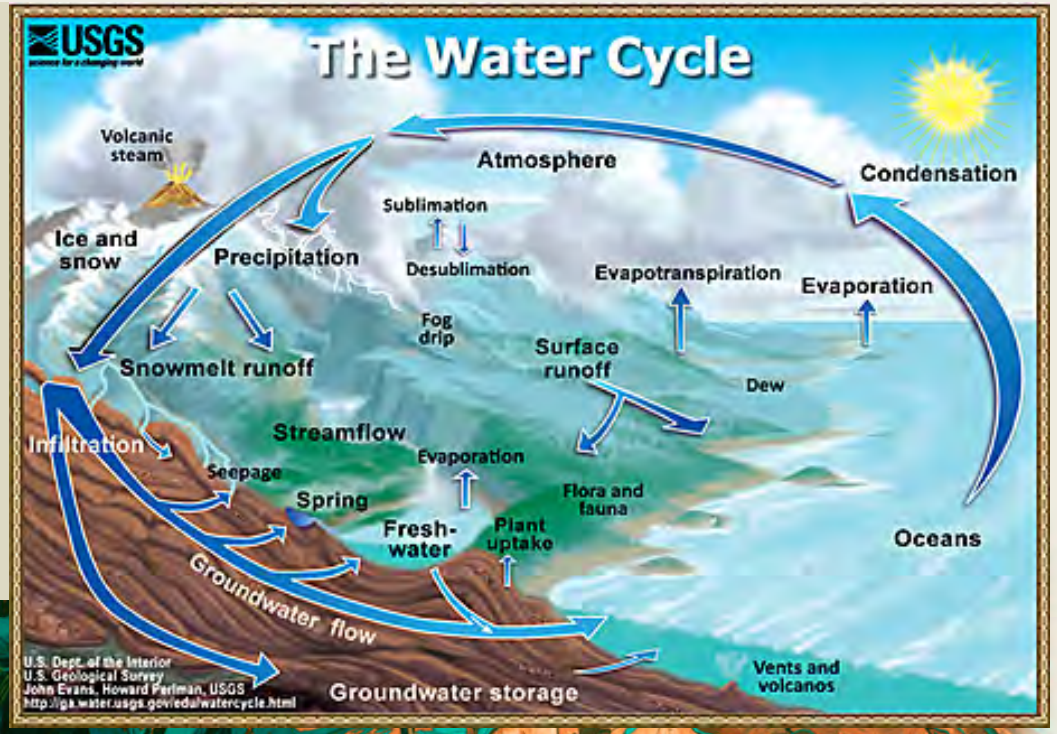
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Landsat & Evapotranspiration 101

Evapotranspiration

Why is evapotranspiration important?

- ET is the second-largest component of the water cycle (after precipitation).
- ET is a major component of consumptive water use and quantifies water that is transferred to the atmosphere.
- Understanding ET is also key to both local agricultural irrigation decision-making and large-scale water management and planning.

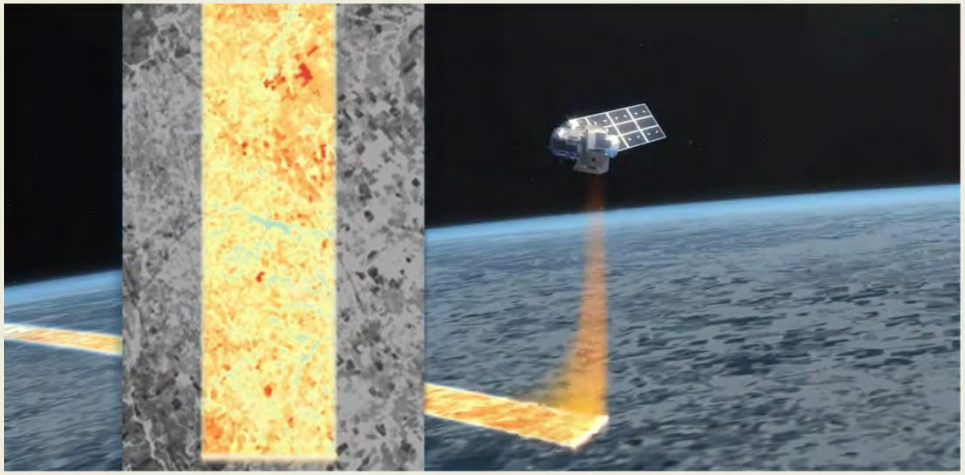


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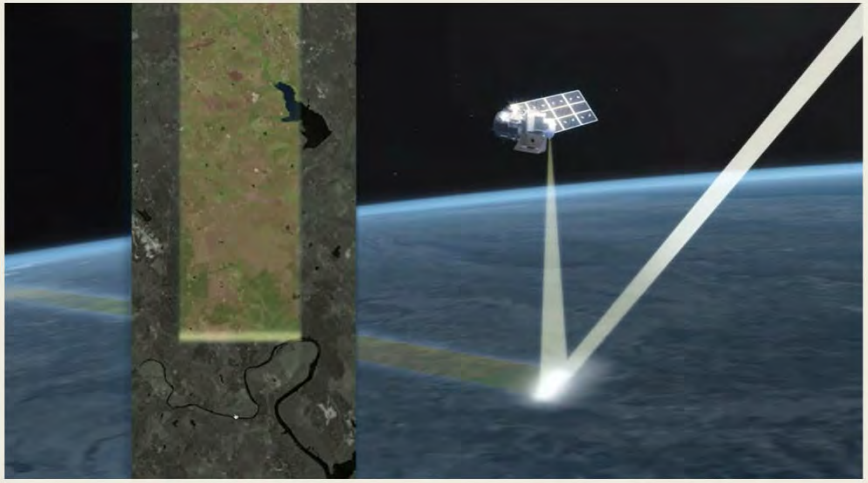
Landsat & Evapotranspiration 101

Landsat-based Evapotranspiration

What does Landsat "see"?



Landsat's thermal infrared sensor measures thermal infrared emissions. Areas with higher land surface temps are associated with lower ET rates, cooler areas are associated with higher ET rates.



Landsat's optical sensor provides measurements in the near infrared and red wavelengths to help users calculate vegetation cover and density.

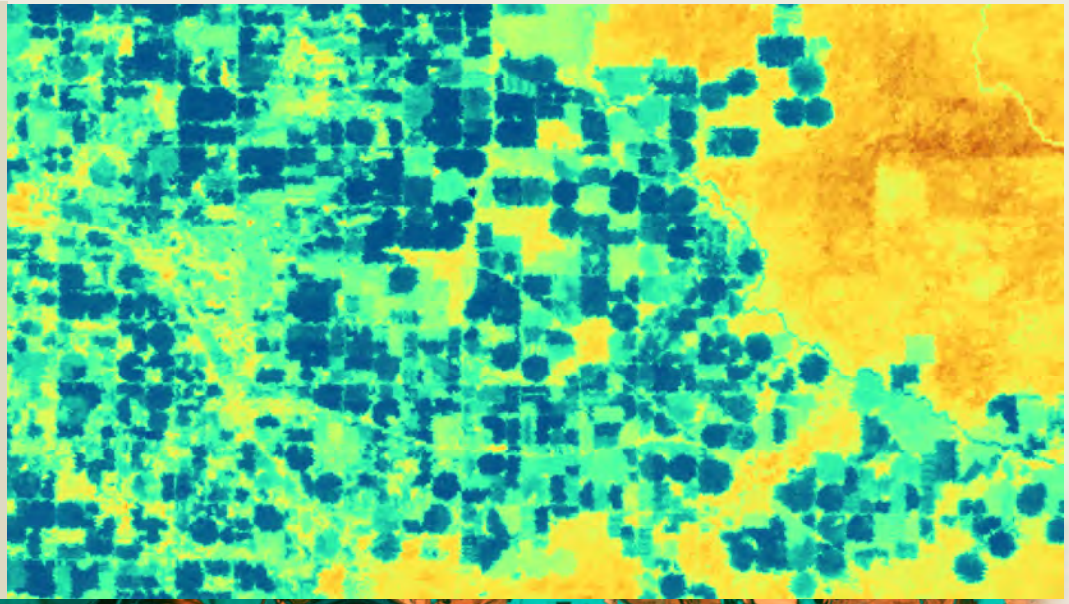
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Landsat and Evapotranspiration

How is it used?

Crop & Water Management Uses

- Design locally driven water conservation and trading programs
- Maximize “crop per drop”
- Develop accurate water budgets and incentive programs
- Policymakers tracking water supplies
- Pull water use information for insurance claims



This thermal band image shows an agricultural region in Idaho. The thermal band - Landsat's band 6 - captures data on land surface temperature. As agricultural growers irrigate farm fields, water evaporating from the soil and transpiring from the plants' leaves absorbs energy and cools the fields.

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Whatever the architecture, the mission holds:

Free. Open. Continuous.

Now — here's what your state can put to work today.

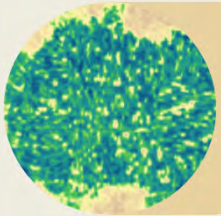
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Landsat-based Evapotranspiration products

Today: Landsat and Evapotranspiration

USGS EROS Product: Provisional Actual Evapotranspiration



Provisional Actual Evapotranspiration

Landsat 4-9, Worldwide, 1982-present

The quantity of water that is removed from a surface due to the processes of evaporation and transpiration

The table below displays how different communities use Landsat Provisional ETa science products in their research.

Community	Potential Use
Farmers and Ranchers	Agriculture, Irrigation Scheduling
Policymakers	Agriculture, Water Management, Water Rights
Water managers, City Planners	Planning, allocation, and water management
Conservation groups	Planning and Water management
International and Non-governmental Organizations	Food security, drought monitoring, and early warning applications

Landsat 4-9 C2 Provisional ETa products are available from the USGS EROS Science Processing Architecture (ESPA) On-demand Interface.

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Landsat-based Evapotranspiration products

Today: Landsat and Evapotranspiration

USGS Partner Product: OpenET

OpenET offers free, field-scale (30 m) evapotranspiration data. It's an ensemble of six peer-reviewed models, running on Landsat thermal and optical data. Covers 48 contiguous US states.

Empowers strategic irrigation decision-making

ET data help determine how much water crops are using over a given period of time, and supports farmers in making data-driven irrigation decisions to maximize both water use efficiency and crop yields.

Supports water management across local, regional, and basin scales

ET data supports strategic decisions across all scales, helping to balance overall supply and demand for communities and ecosystems.

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OpenET data are free and open at https://etdata.org/

Landsat-based Evapotranspiration products

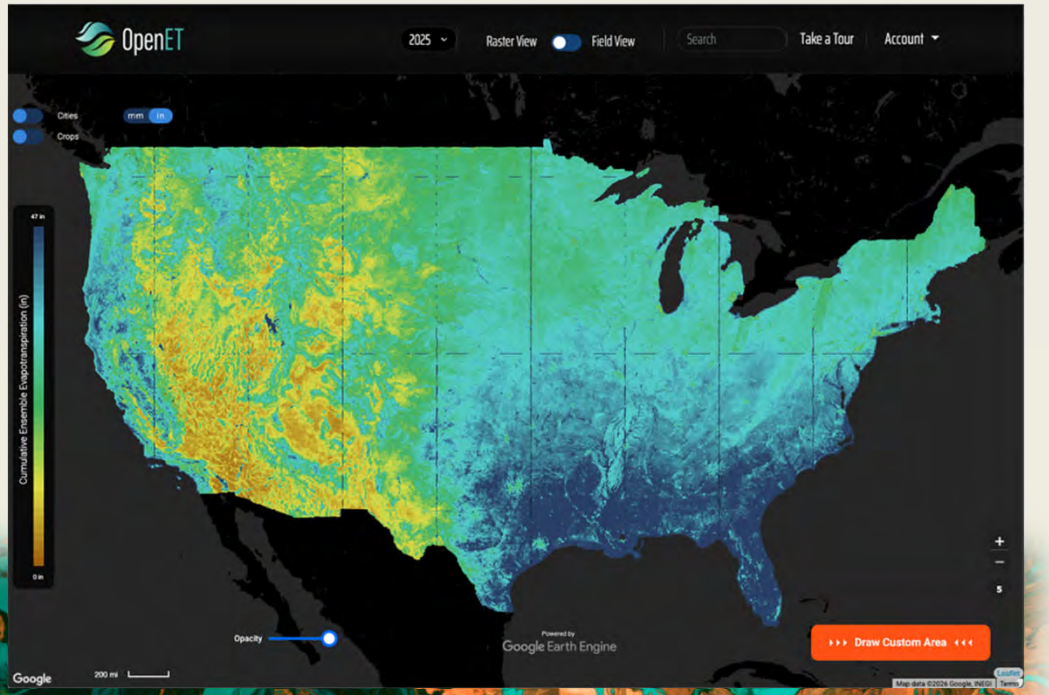
Coming soon: Landsat and Evapotranspiration

High-Resolution Evapotranspiration (ET) Product within HLS

In the 2024 Satellite Needs Working Group assessment, federal agencies requested a global ET product.

This solution will produce evapotranspiration data at field scale for the entire globe, leveraging the OpenET platform.

This SNWG solution answers the decision-making needs of stakeholders in agriculture, land management, and urban planning. High-resolution ET will support American crop productivity, water security, wildfire risk monitoring, and ecosystem health assessments. It will also enhance understanding of irrigation demands and water consumption.



This map shows levels of evapotranspiration, as measured by the OpenET project, across the continental United States.

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Landsat in Action

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Landsat in Action

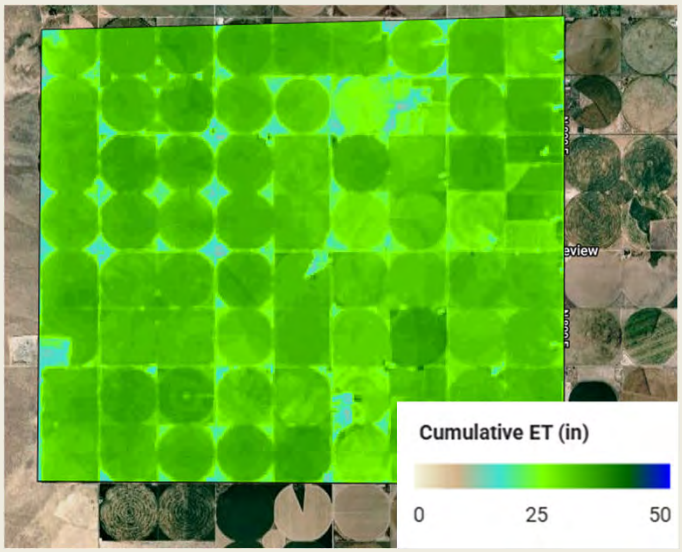
Case Study: Idaho Department of Water Resources (IDWR)

Problem: Idaho water managers need to track how much water agricultural irrigation consumes and returns to the aquifer, especially to build accurate groundwater models and water budgets across large agricultural areas.

How Landsat Helps: IDWR runs the METRIC model on Landsat imagery to map evapotranspiration, and pairs it with a random forest machine learning model using Landsat and Sentinel-2 data to map irrigated acreage.

The Result: Combining these two products lets IDWR isolate ET specifically from irrigated land, enabling accurate estimates of groundwater withdrawn for irrigation and water returned to the aquifer from surface-water irrigation — key inputs for the state's groundwater models.

More information here: IDWR Mapping Evapotranspiration



Screenshot of the IDWR ET Viewer. 2023 cumulative ET near Monteview, Idaho.

Landsat in Action

Case Study: Gallo Winery

Problem Gallo Winery, the largest winery in the world, needed to reduce water usage by 50% across thousands of acres of California vineyards without sacrificing yield or fruit quality. They lacked a way to accurately measure how much water its vines were actually using.

How Landsat Helps Landsat's thermal imagery and 30-meter resolution allowed researchers to calculate evapotranspiration across Gallo's vineyards, revealing variability in water needs even within a single vineyard. This enabled precise irrigation adjustments matched to actual plant needs.

The Result Gallo has already cut water use by 25% and continues refining its irrigation practices toward its 50% goal. The work also helped lay the foundation for OpenET, a Landsat-based platform now delivering water management tools to growers and water managers across the western United States.

Learn more here



"Landsat is the single most valuable tool that we have used." – Nick Dokoozlian, Gallo Research Group

Other Relevant Landsat Products



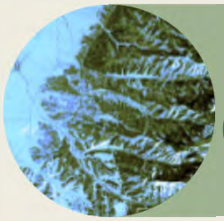
Data & Products

USGS Level-3 ARD Tile-Based Science Products & Applications

USGS already did the analysis — you just need the layer.

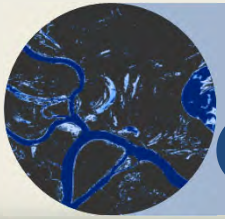
Advanced analysis of water, fire and snow

USGS transforms Landsat data into value-added science offering western states in-depth analyses of landscape dynamics.



Fractional Snow Covered Area

1. Snowpack trends
2. Snowfall patterns & drought monitoring
3. Fire management with snow level data



Dynamic Surface Water Extent

1. Water use & management
2. Habitat assessment
3. Flooding assessment



Burned Area

1. Fire severity trend monitoring
2. Forest management
3. Burned area probability

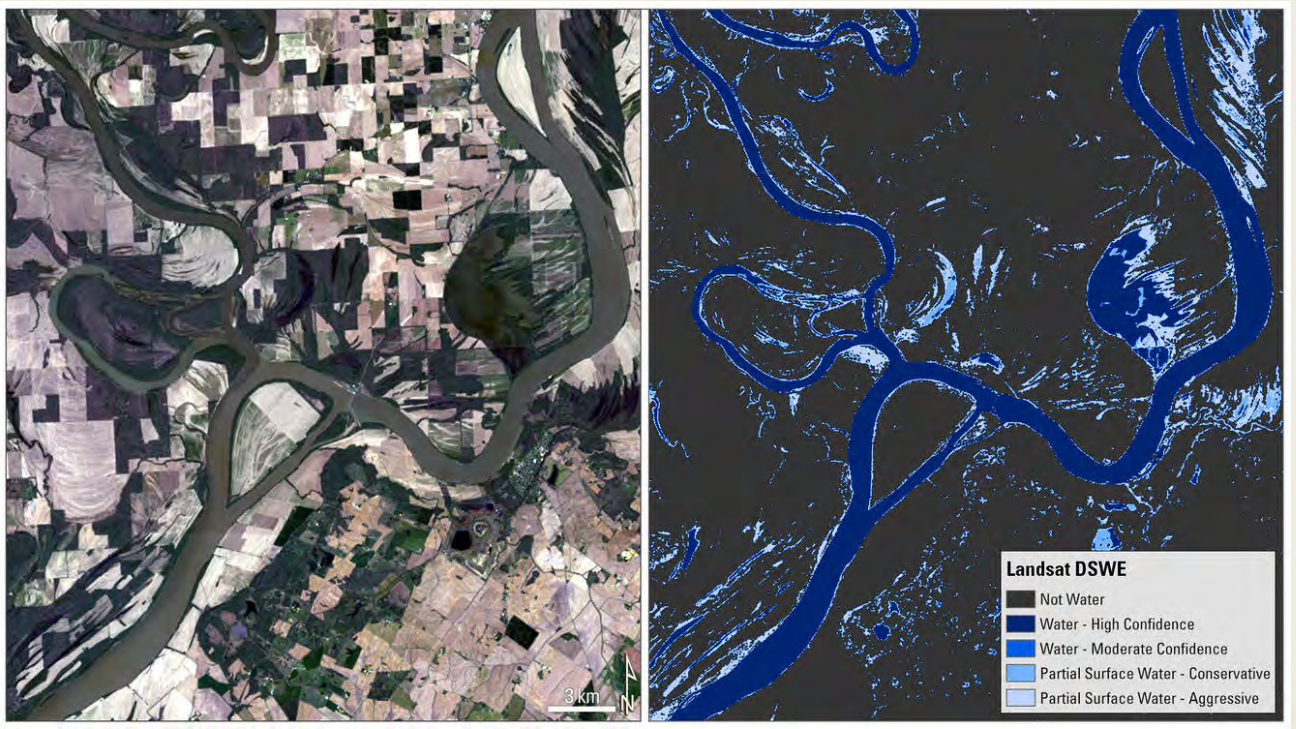
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More information here: Landsat Science Products

Data & Products

USGS Dynamic Surface Water Extent

The Landsat Collection 2 (C2) Level-3 Dynamic Surface Water Extent (DSWE) product provides raster layers that represent surface water inundation per-pixel in Landsat data. C2 DSWE contains six acquisition-based raster data products relating to the existence of surface water.



Example of the Landsat Collection 2 Dynamic Surface Water Science Product showing the Confluence of the Wabash and Ohio Rivers on April 12, 2021,for tile h021V010. Left: Landsat Collection 2 U.S. Analysis Ready Data Surface Reflectance image, Right: Dynamic Surface Water Extent (INTR layer)

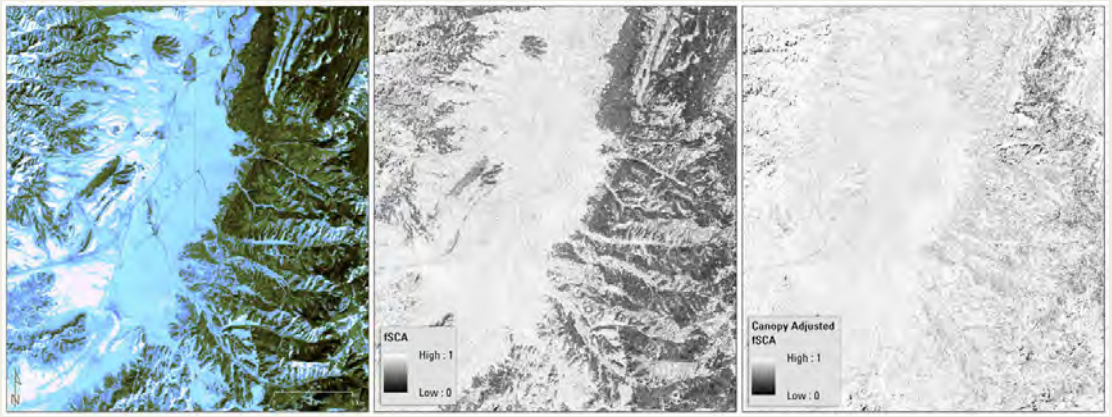
More information here: DSWE (Data latency: 5-7 days)

Data & Products

USGS Fractional Snow Covered Area

The Landsat Collection 2 (C2) Fractional Snow Covered Area (fSCA) product provides per-pixel fractional snow cover maps that indicate the percentage of pixels covered by snow for Landsat 4-9 data.

While Landsat's acquisition frequency limits analysis of short-term snow cover variations, longer term changes in snow cover duration and persistence can be detected.



Example of the Landsat Collection 2 Fractional Snow Covered Area (fSCA) Science Product showing an area in the Dixie National Forest in Utah on February 28, 2021 for tile h007V010. Left: Landsat 8 Collection 2 U.S. Analysis Ready Data Surface Reflectance image (Bands 6,5,4), Middle: fSCA, and Right: Canopy Adjusted fSCA.

More information here: Fractional Snow Covered Area
(Data latency: ~ 1 week)

USGS

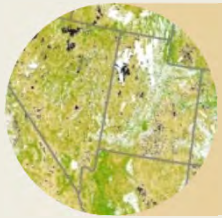
Data & Products

Land Cover Data Products & Applications



USGS National Land Cover Database Product Suite

1. Asset management
2. Habitat mapping
3. Urban planning
4. Natural hazards assessment



USGS & BLM Rangeland Condition Monitoring Assessment and Projection

1. Analyze vegetation change
2. Assess ecosystem health
3. Wildfire risk assessment
4. Rangeland conservation



DOI & USDA-FS LANDFIRE Product Suite

1. Modeling wildfire risk
2. Wildlife habitat analysis
3. Tracking landscape disturbances
4. Fuels treatment planning

USGS

Resources:

- What is the best land cover product for my application?
- Multi-Resolution Land Characteristics (MRLC) Consortium

Data & Products

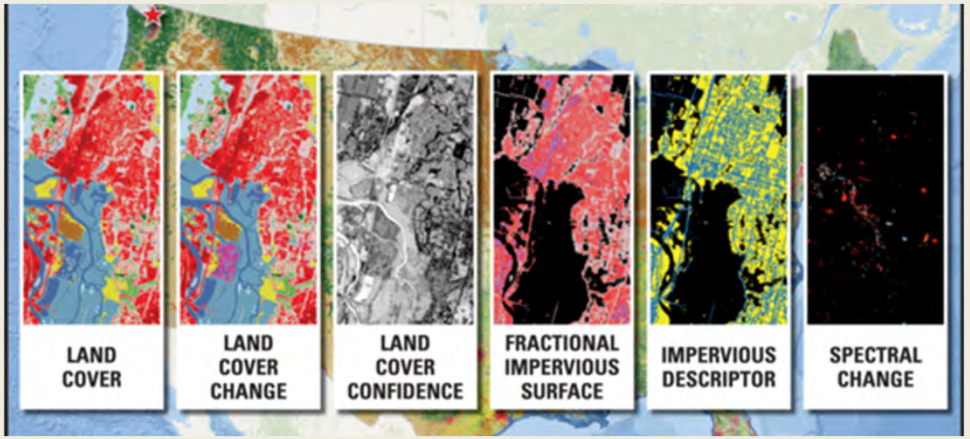
USGS National Land Cover Database (NLCD) Product Suite

What it is: USGS's Landsat-based land cover product, classifying land into 16 categories (forest, urban, agriculture, etc.) plus impervious surface and tree canopy

How long: 1985–present

Resolution: 30 meters
Cadence: Now updated annually (previously every 2–3 years)
Access: Free download or cloud access on a variety of platforms

Why use it: Land use planning, watershed/water quality assessments, wildlife habitat modeling, urban growth tracking



Annual NLCD offers a suite of six annual land use and land cover change in the conterminous United States. Annual NLCD Collection 1.2 is available now.

More information here



Data & Products

Data Access

USGS Supported Applications

- USGS Earth Explorer
- Landsat Commercial Cloud Data Access
- Bulk Download Web Application (BDWA)
- Machine-to-Machine (M2M) API
- Global Visualization Viewer (GloVis)
- EROS Science Processing Architecture (ESPA)
- NASA Application for Extracting and Exploring Analysis Ready Samples (AppEEARS)



Others: Many companies and institutions mirror the Landsat archive (Google Earth Engine, Esri Landsat Explorer, Copernicus Browser)

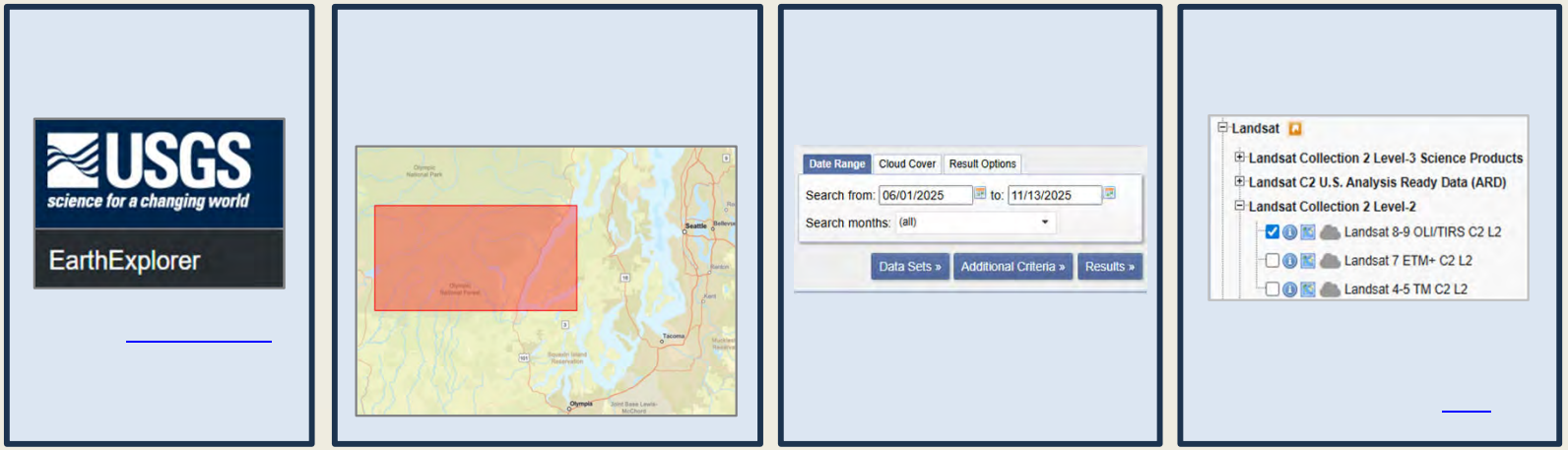
Getting Started
&
Next Steps

USGS



Getting Started & Next Steps

Accessing Landsat Data Using USGS Earth Explorer



Getting Started & Next Steps

Where to Get Help & Stay Connected

USGS EROS User Services

First point of contact for data access and technical questions about science products

custserv@usgs.gov

USGS National Land Imaging Program

Tim Newman
Program Coordinator
tnewman@usgs.gov

Latest in Landsat Newsletter

Monthly updates on missions, products, and milestones

sign-up link

Earth Observation Trainings

- EROS User Experience Webinar Series
- NASA Applied Remote Sensing Training Program
- USGS Introduction to aquatic remote sensing



Key Takeaways

50+ years of free, consistent data
The longest continuous Earth observation record available to anyone

Products keep getting more usable
ARD and Level-3 science products remove the processing burden

Direct relevance to core agency missions
Agriculture, water, fire, land use, disaster response, and more

More capability is coming
Landsat 10 continues the legacy with improved resolution and bands

USGS





Questions & Discussion

Thank you to the WSWC for the opportunity to share information about Landsat

U.S. Geological Survey | National Land Imaging Program