

Landsat Archive Milestone: 2,000,000 scenes!

The Landsat archive at USGS EROS is a continuous record that stores data from the very first Landsat mission up to the present day acquisitions of Landsat 5 and Landsat 7. Not all of these data are available to purchase (particularly the oldest), because of issues that are a consequence of their age. Every day, the staff at USGS EROS seek ways to make these older scenes available to the user community. In addition, the Landsat Ground Station downlinks about 300 new scenes daily. Between these two efforts, we have reached an exciting milestone - 2 million scenes! The effort is still underway to make all of the oldest and rarest Landsat data available.

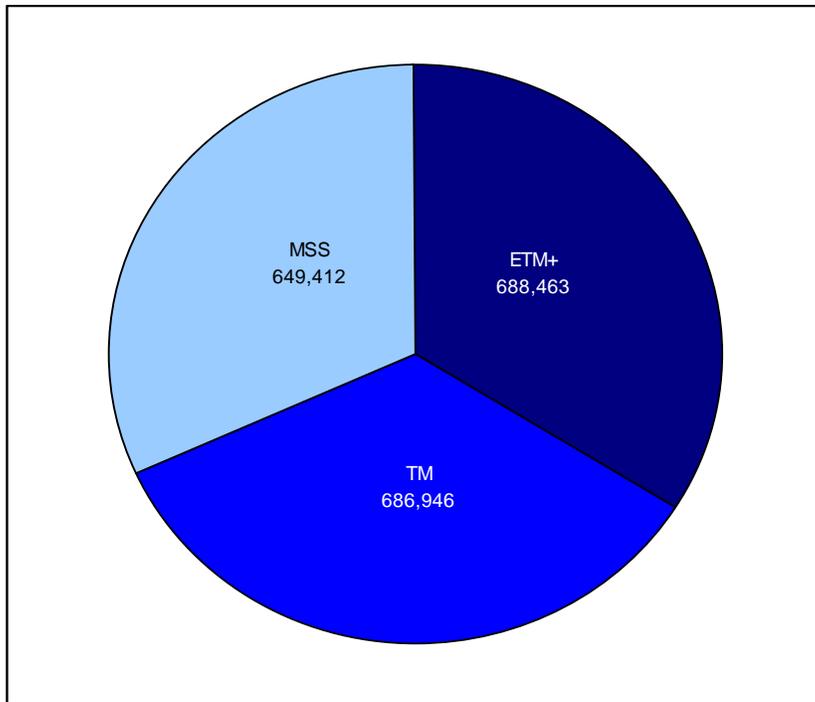


Figure 1. Total number of archived Landsat scenes.

Earth from Space traveling exhibit

Landsat data is featured in a Smithsonian National Air and Space Museum traveling exhibit called *Earth from Space*. The exhibit opened on November 11, 2006 and consists of 41 large-scale banners with satellite imagery that has been recorded over the past 30 years. The website component of *Earth from Space* can be found at <http://www.earthfromspace.si.edu>, where you can view satellite images that focus on the Earth's geology, biosphere, and atmosphere, showing the influence of people on the landscape. It also outlines some basic features of each satellite that are showcased in the exhibit.

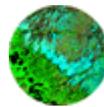
EARTH from SPACE

Online Exhibition

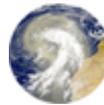
The earth, our home in space, is a varied and dynamic place. Since the advent of the aerospace age, we have gained new insights into how our planet works. Today dozens of orbiting satellites reveal structures and patterns on the earth's surface that have never been seen before.

These satellites carry sensors that allow us to observe oceans, mountains, land surfaces, human activity, and changes in global climate. The images they provide have many important applications, from mapping city streets to understanding long-term climate changes.

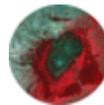
Most satellite imagery is used for scientific or technical purposes, but these complex pictures can also be appreciated aesthetically. Satellites detect subtleties and variations that human eyes cannot, providing unique and beautiful views of our planet.



Living Planet



Water & Air



Structure of the Land



The Human Presence



Satellite Technology

EarthNow! Goes Live

The EarthNow! image viewer (<http://earthnow.usgs.gov>) went live on November 2, 2006 at the USGS Center for Earth Resources Observation and Science (EROS). EarthNow! was developed by the AmericaView program and the Landsat Project and displays data received from the Landsat 5 and Landsat 7 satellites as they pass over the conterminous United States. When a Landsat satellite passes within range of the Landsat Ground Station at USGS EROS, image data are downlinked and displayed in real time. When Landsat 5 and 7 are not in range, the ten most recent passes are displayed. EarthNow! was created as an outreach tool by the Landsat project at EROS, and a version was installed on November 11 at the National Air and Space Museum in Washington, D.C.

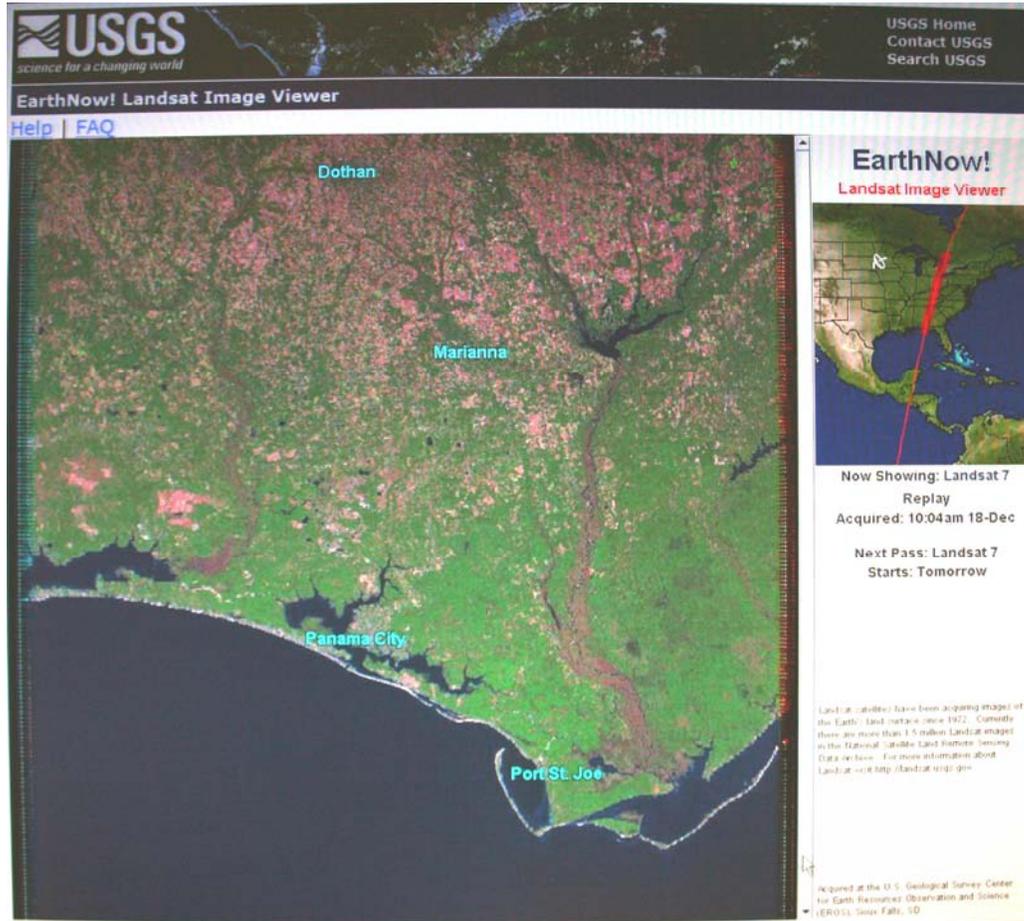


Figure 2. Screen capture of the EarthNow! image viewer.

Landsat Spotlight

Recently a landform called a chevron was noted on a Landsat 7 image of Madagascar. These chevrons may have been formed by a mega-tsunami produced 4,800 years ago by a meteorite or comet impact with the Indian Ocean.

Tsunami-generated chevrons rarely consist of a single feature but are nested like the stripes on a military uniform. The Ampalaza chevron field on the left consists of the overall v-shaped deposit and smaller nested chevrons, each with up to 20 m of relief. The axes of the chevrons indicate the direction of flow, in this case from the southeast. The tsunami flowed across 40 km of land surface at an estimated depth of 90 m. The Fenambosy chevron field on the right has lost its overall v-shape because the water's flow was spilt landward over an escarpment 200 m above sea level. Wind has reshaped the individual chevrons more than at Ampalaza. Both chevron fields were formed within the last 10,000 years, most likely around 2,800 BC. Seaward of the main Fenambosy chevron field, note the irregularly spaced chevrons, which may represent an older event. The Madagascar chevrons are far from unique, as similar landforms have been identified on the coastlines of all major oceans.

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Ancient Crash, Epic Waves - *The New York Times*, Science section, Pub. November 14, 2006

<http://www.nytimes.com/2006/11/14/science/14WAVE.html?ex=1321160400&en=35b395ffd080eb47&ei=5090&partner=rssuserland&emc=rss>

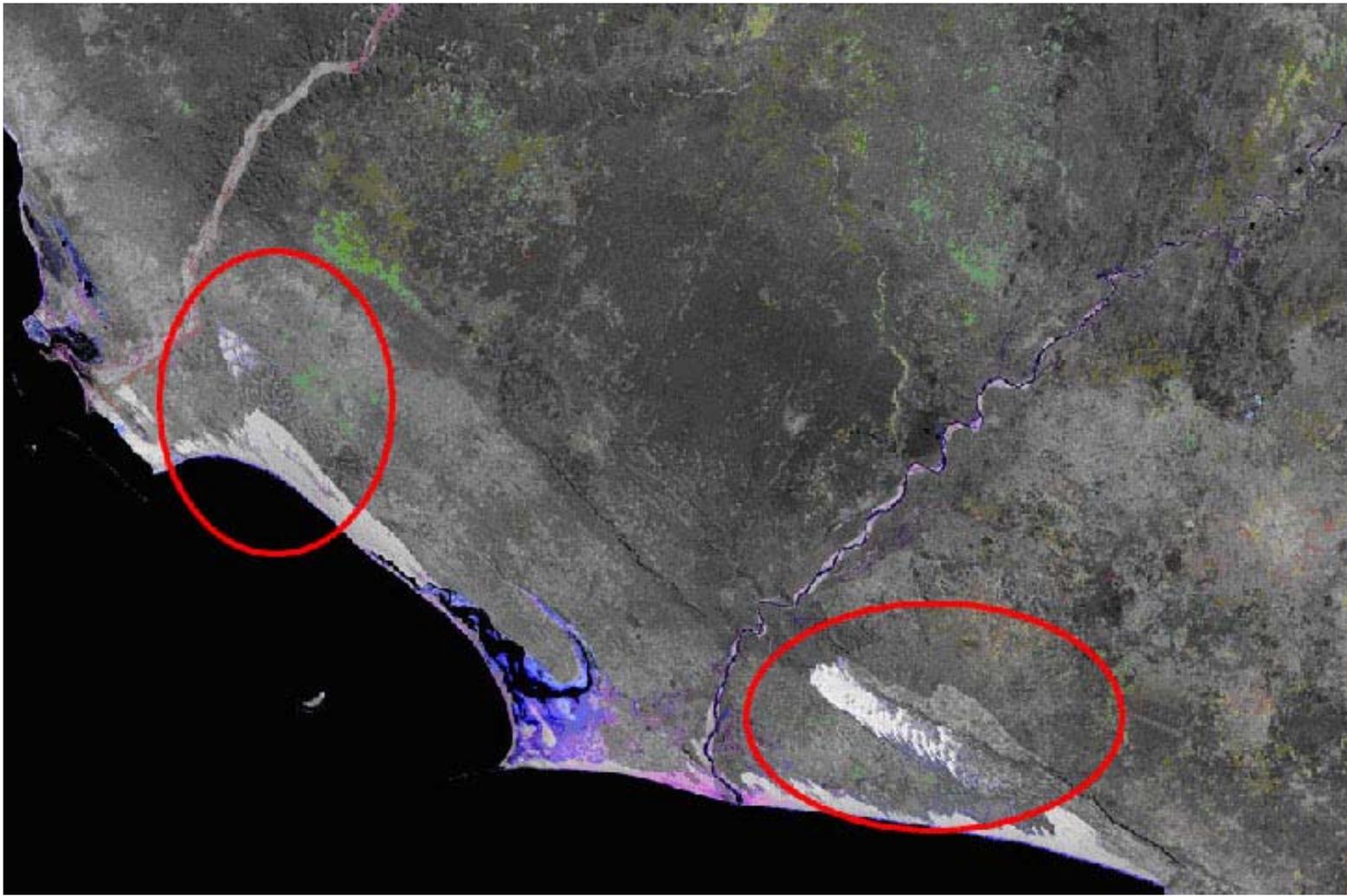


Figure 3. The chevrons are located within the circles.

Did you know...

That you can set up a **Standing Request** in Earth Explorer?

The Standing Request feature was developed to enable customers to automatically be notified of newly acquired Landsat images.

To set up a standing request, you must first select a data set and run a search, setting the Path & Row as well as cloud cover. In the Search Results Summary page, click on the **Setup Standing Request** icon. You then set additional conditions, which are shown in the graphic below.

Setup or Edit Standing Requests

Standing Request Information	
How often do you want this search to execute? Tip	Daily <input type="button" value="v"/>
Enter the date that this standing request will terminate: Tip	September <input type="button" value="v"/> 30 <input type="button" value="v"/> 2007
How do you want to be notified when new items are found? Tip	E-Mail <input type="button" value="v"/>
What options do you wish to include in your notification? Tip	<input checked="" type="checkbox"/> Browse Image (if available) Example <input checked="" type="checkbox"/> Metadata (text) Example <input type="checkbox"/> Metadata (Pipe Delimited) Example <input type="checkbox"/> Metadata (FGDC) Example
Do you want to automatically order items that are found during the Standing Request Search? Tip	No

Helpful Tips

Please provide a name for the standing request:

Standing Request -Area of Interest

When new scenes are added to the archive and they meet the criteria determined in the Standing Request, an email notification can be sent to you, alerting you of new acquisitions, along with the browse and metadata details (if these are selected in the Standing Request Information Box). Items can be automatically ordered if this option is selected.

Landsat History

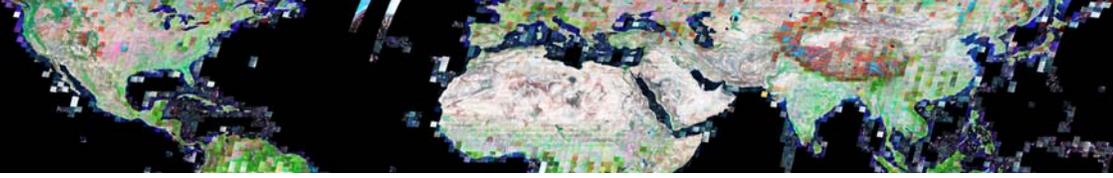
(This story was taken from the [Landsat Legacy registry site](#) at the NASA Goddard Space Flight Center.)

Since the Landsat project's inception in 1965, Landsat has stood at the forefront of space-based Earth observation and has been the trailblazer for remote sensing as we know it today. But the forty-year history of Landsat has been tumultuous. The program has been variously administrated by a multitude of government agencies and a private company; consequently, the program documentation has become widely disseminated over the course of the seven Landsat missions.

In an effort to gather Landsat's technical documentation, the NASA Landsat Project Science Office (LPSO) is teaming with the U.S. Geological Survey and the NASA Goddard Space Flight Center Library to create an archive of essential Landsat documentation. The archive, dubbed the Landsat Legacy, will house technical-, policy-, and science-related documents with an emphasis on internal technical papers. Journal articles and other privately copyrighted materials are outside the scope of the project. It is the project's ultimate goal to have an online freely accessible archive of Landsat documentation that can be used by the general public by late 2006.

In order to gather the forty years worth of documentation, the LPSO is soliciting those who have been involved with the Landsat program for Landsat-related materials that have been stored in personal archives. The registration process involves entering basic information about these documents into a web-based registration system. The LPSO will review the registration records, select appropriate materials, and subsequently contact potential donors to arrange a method of document submission. Once pertinent documents have been scanned, cataloged, and archived, the Landsat Legacy document repository will provide a valuable resource for future generations of Landsat data users.

For more information about the Landsat Legacy project, please visit the [Legacy registry site](#).



Interactive Spectral Characteristics Plotter

“What are the best spectral bands to use for my study?”

This is a common question asked by users of remotely sensed data, novice and expert alike. Landsat Data Continuity Mission (LDCM) scientists have developed an interactive tool that helps visualize how bands of different satellite sensors measure the intensity of the wavelengths of light (the relative spectral response, or RSR). By overlaying the curves from different spectra, users can determine which bands of the selected sensor will work best for their application. It is also possible to overlay the atmospheric windows, as well as convolve the feature's spectrum with each sensor's RSR. Information and the link to the tool can be found at http://ldcm.usgs.gov/spectral_plotter.html.

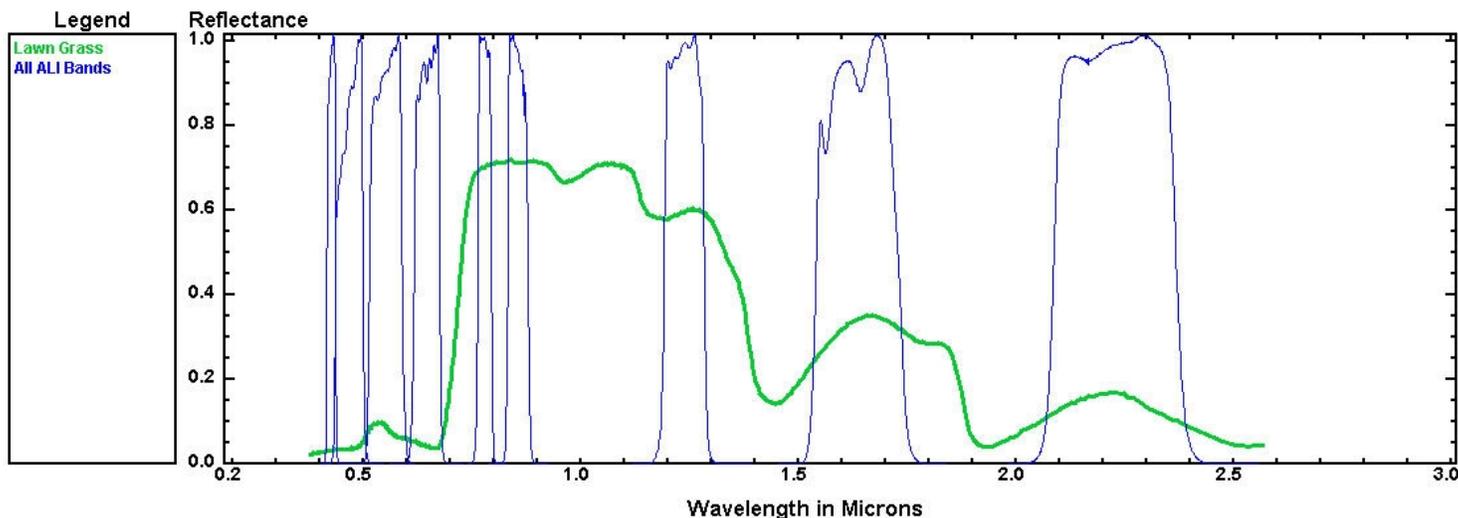


Figure 1. Spectral graph

Landsat Sales for the 2006 Fiscal Year

The Landsat Project distributed over 11,500 Landsat 1- 7 scenes. Customer requests for Landsat 7 SLC-off data continued to increase steadily over last year.

Landsat FY06 Sales

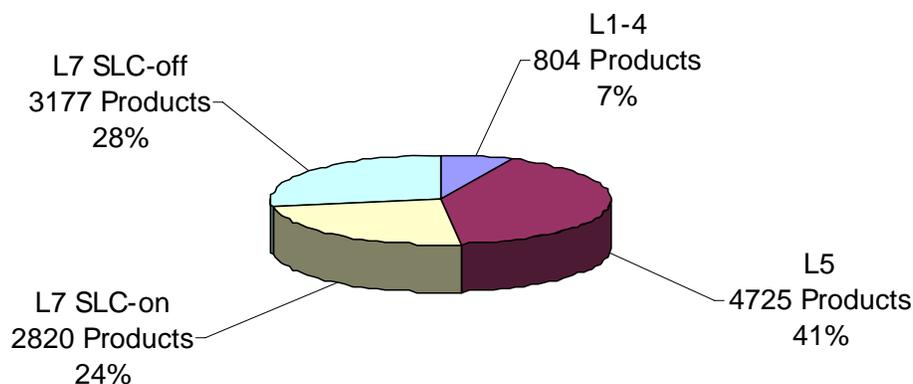


Figure 2. Landsat data sales for the 2006 fiscal year.

The Mid-Decadal Global Land Survey

The U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA) have joined together to augment a series of decadal global land surveys with a new one based around the 2005-2006 time period. The Mid-Decadal Global Land Survey will be similar to surveys from the 1970's, 1990, and 2000, but will increase the total coverage and, for the first time, include Antarctica.

The Mid-Decadal survey has been organized into two phases: the USGS leads Phase 1, Data Acquisition, and NASA leads Phase 2, Product Generation. In Phase 1, primary consideration is given to the data acquisition specification for seasonality, based on geographic location, climate, and cloud cover.

Landsat 7 is a global survey mission, and much of the data for the entire Earth's surface is already in the Landsat archive. USGS holdings of Landsat 5 data, however, are restricted in geographic scope to scenes in the United States. To complete a global survey with Landsat 5, all scenes outside the United States will be acquired by our international cooperators around the world. The Landsat network of international cooperators is offering unprecedented support to complete the Mid-Decadal survey effort.

Landsat Data for [International Polar Year](#) Studies

The first International Polar Year (IPY) was in 1882 – 1883 and was the first of many opportunities to broaden our understanding of the Polar Regions through interdisciplinary research. The next IPY will run from March 2007 to March 2008 to allow research on both poles during the winter and summer seasons. Research relating to the IPY will cover a wide variety of topics, from social change in Polar Regions to shifting ice shelves in Antarctica. One IPY effort is the first Landsat mosaic of Antarctica. With over 1,000 scenes, it will be one of the largest mosaics of Landsat ever created. These data will be hosted free to the public through a user portal that is currently under development. Scene-based data, and three versions of the mosaic (panchromatic; 3,2,1 combination; 4,3,2 combination), will be web-enabled for download as they become available.

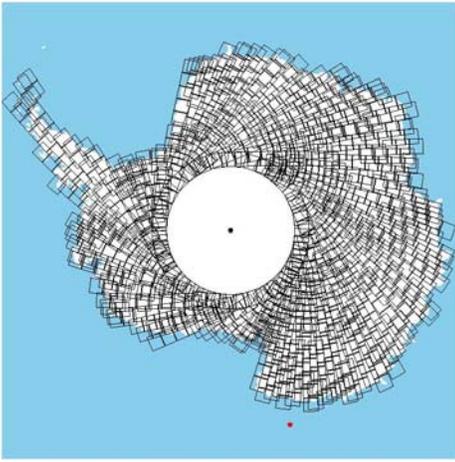


Figure 3. This map represents the extent of the Landsat mosaic. Because of Landsat 7's near-polar orbit there is a "hole" at the South Pole.

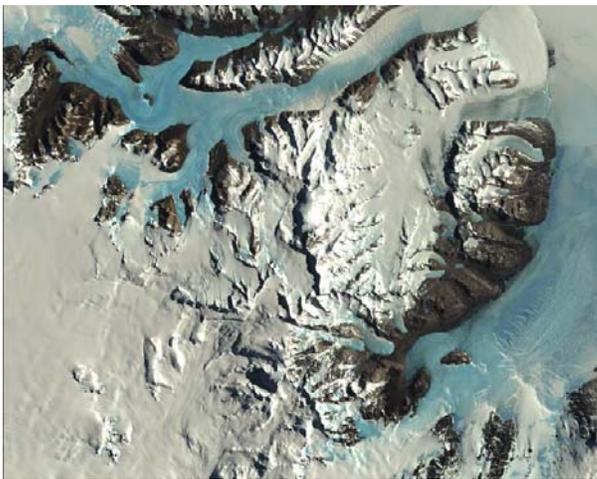


Figure 4. This scene is an example of the beautiful imagery that the ETM+ sensor has acquired of Antarctica. (Path 128 - Row 108; September 9, 2006)

EarthNow! Goes Live

The EarthNow! Landsat image viewer (<http://earthnow.usgs.gov>) went live on November 2 at the USGS Center for Earth Resources Observation and Science (EROS). EarthNow! displays data received from the Landsat 5 and Landsat 7 satellites as they pass over the United States. When a Landsat satellite passes within range of the ground station at USGS EROS, image data are downlinked and displayed in near-real time. When Landsat 5 and 7 are not in range, the most recent 10 passes are displayed. EarthNow! was created as an outreach tool by the Landsat project at USGS EROS, and a version was installed on November 11 at the National Air and Space Museum in Washington, D.C..

Landsat 5 for Alaska - Successful 2006 Season

The multi-agency collaboration to [capture] Landsat 5 data for Alaska for the 2006 season was a success, with 4,780 scenes acquired over Alaska, eastern Siberia, and western Canada. Landsat 5 depends on direct downlink capabilities to transmit images to the Earth. Starting in the spring of 2005, USGS EROS, the National Oceanic &

Network of Alaska (GINA) worked together to use the FCDAS's receiving station, GINA's network and user services, and USGS EROS processing, archive, and user services to capture data within the FCDAS [Station Mask](#). Since the spring of 2005, the program has contributed 8,669 scenes to the National Satellite Land Remote Sensing Data Archive.

Much to the relief of Alaska residents, the 2006 fire season was mild compared to the record breaking 2004 and 2005 seasons. Nonetheless, Landsat 5 data for Alaska has proven invaluable to fire managers and ecologists for mapping and assessing the severity of 2006 fires, and studying the ongoing ecological recovery from fires in previous years. Fire scientists are not the only users of Landsat 5 data, and scientists and engineers will also benefit from the record of Alaska captured in 2006 through this unique cooperative effort.

ASPRS Moderate Resolution Remote Sensing Survey Results are in!

The American Society for Photogrammetry and Remote Sensing (ASPRS) recently undertook a survey of the Landsat user community on the future of U.S. land imaging at moderate resolution (5-120 meter pixels). The results were presented to the Future of Land Imaging Interagency Working Group (FLI IWG). This team was established in 2006 by the White House Office of Science and Technology Policy and directed to create a plan for an ongoing, operational U.S. land imaging program with technical, financial, and management stability. We've included a few of the survey's key findings here.

1,295 voluntary respondents participated.

- 71% of those participants use Landsat as the primary source of moderate resolution data.
- 72% stated that Landsat is a primary, critical dataset for their applications.

The top 5 reasons participants use Landsat data instead of other remote sensing data are (in order of importance):

1. Landsat data are more accessible.
2. There is a large Landsat archive containing over 30 years of consistent data.
3. Landsat data are relatively less expensive.
4. The extent of Landsat scenes is more appropriate for the respondent's project.
5. Landsat has better temporal resolution (repeat coverage).

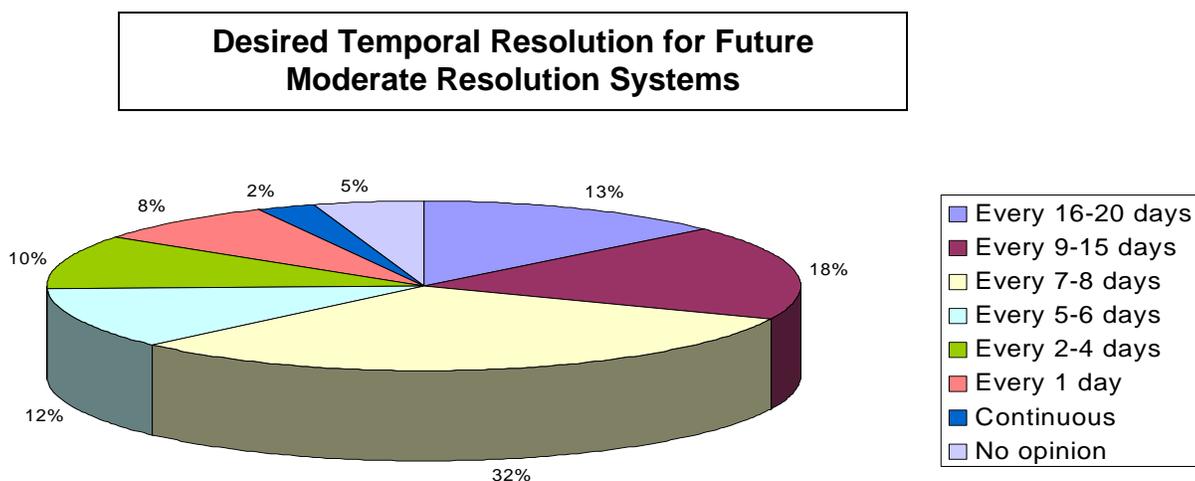


Figure 5. Desired temporal resolution graph

The top five ways to increase the utility of moderate resolution imagery are (in order of importance):

1. Lower cost data
2. More frequent temporal coverage
3. Finer spatial resolution
4. Better spectral resolution
5. Easier access to data

The survey states that the value attributable to the potential loss of Landsat imagery is estimated to be **\$935.8 million/year**. Some 37% of the respondents believe that it would not be possible to provide the same level of service without Landsat, while 13% stated that they would have to discontinue their programs if Landsat data were not available.

For further information about the survey, visit <http://www.asprs.org/news/fli/> or contact ASPRS at FLIsurvey@asprs.org.

To learn more about the FLI IWG effort, visit <http://www.landimaging.gov/index.html>.

Landsat Science Team Announced

The team has been chosen, the announcement is out, and plans are underway for the first Landsat science team meeting.

"It was tough to decide," stated Dr. Thomas Loveland of the U.S. Geological Survey (USGS), "There were so many good proposals." The team was chosen through an intense panel-review process, and USGS announced the winners on October 16, 2006.

The team has already started work, but will come together for the first time in January 2007, at the USGS Center for Earth Resources Observation and Science (EROS) in Sioux Falls, South Dakota. Each member of the team is researching a specific topic, and the overall goal of the team is to enable more effective use of archived Landsat data and to help identify and address the needs of users of future land-imaging data.

Topics under investigation include:

- water and natural resource management
- radiometric calibration
- change detection and monitoring
- cloud detection and avoidance
- biophysical products
- extending the long term acquisition plan for the archive

Dr. Thomas Loveland, USGS, and John Dwyer, Science Applications International Corporation (SAIC), contractor to USGS, will lead the team and coordinate their efforts. While each member will conduct specific research, team members will also serve as representative users to advise the National Aeronautics and Space Administration (NASA) and USGS in their Landsat Data Continuity Mission (LDCM) development efforts.

For more information on the members, their research areas, and the mission of the LDCM Science team, see the official USGS press release at <http://www.usgs.gov/newsroom/article.asp?ID=1571&from=rss> and the Science section of the LDCM web site: <http://ldcm.usgs.gov/intro.html>.

L5 Solar Array Update

On August 16, 2006, Solar Array drive for Landsat 5 exhibited continued erratic behavior that had plagued the satellite since early 2005. As a result the Solar Array was placed in a fixed position, or spacecraft 'noon', to maximize the batteries' power charge. Quick action and innovative thinking from Mission Operations staff resulted in the implementation of a modified operations concept for pitching the spacecraft during the beginning and end of each orbit's daylight phase, which will allow for maximum power collection from the static solar array. This has resulted in a quick return to full operations, including downlinks to all international cooperator stations.

New L5 Mission Operations Center Contractor Selected

The USGS recently awarded a contract to Honeywell Technology Solutions, Inc., for daily Landsat 5 satellite flight operations. The USGS manages and operates Landsat 5, which has been in service for over 22 years.

L7 Solid State Recorders

The solid state recorder on Landsat 7 enables images to be acquired around the world for downlink to a Landsat ground station. There are 24 individual boards that make up the solid state recorder. One of the boards was turned off in August following a problem with transmitting image data. Three boards had been turned off previously for similar reasons. Fifty-five scenes were lost as a direct result of the failure and 19 subsequent scenes were lost that would have been acquired while the system was being reconfigured. The four boards that are no longer turned on represent 16.7% of the total solid state recorder capacity. Although the loss of four boards does not significantly affect the mission, the Flight Operations Team is investigating the possibility of recovering the boards.

Did you know?

GloVis (Global Visualization Viewer – glovis.usgs.gov) has a feature that allows users to upload their own shape files to display as a map layer. These files must be in geographic (latitude, longitude) coordinates and should be referenced to either the WGS84 or NAD83 datum.

1. Access GloVis at <http://glovis.usgs.gov>
2. In the viewer application window, go to Map Layers and select Read Shapefile.
3. Select the shapefile name from your directory and click Open.
4. Choose a color for the layer and click OK. The layer will automatically load over the images.
5. To turn the layer on and off, go back to Map Layers in the application window and select/deselect the checkbox next to the shapefile name.

For more tips on using the shapefile in GloVis, please access the help document at <http://glovis.usgs.gov/ImgViewerHelp.html>

Landsat History

The Landsat Project began in 1965. The first satellite was launched on July 23, 1972.

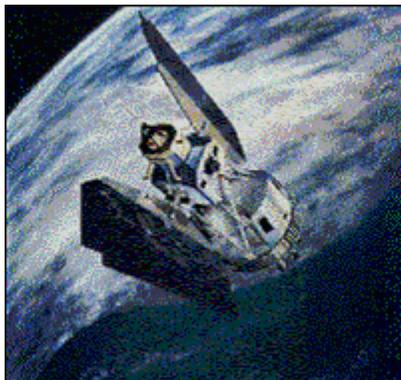


Figure 6. Landsat 1

The first two satellites launched were not called Landsat. Their original designations were: ERTS – A and ERTS – B (Earth Resources Technology Satellite). Prior to the launch of ERTS – B the name Landsat was adopted. ERTS – A was renamed as Landsat 1 and ERTS – B left the launch pad as Landsat 2.

The data download rate of Landsat 1 was 15 Mbps (megabits per second). A megabit is equal to one million bits. By comparison, the data download rate for Landsat 7 is 150 Mbps.

2006 Landsat Updates

January Special 2006

Landsat Data Continuity Mission

The Administration has directed NASA and the USGS to team up on development, launch, and operation of a “free-flyer” Landsat Data Continuity Mission, wherein NASA will procure an on-orbit data acquisition capability and then turn it over to the USGS to operate in order to ingest, archive, process, and distribute Landsat-type data products. By some estimates, such a capability would become operational early in 2011.

See the [Landsat Data Continuity Strategy Adjustment Memo](#) (December 23, 2005)

January 2006

Landsat Proves “Our Changing Environment”

The United Nations Environment Programme (UNEP) has published *One Planet, Many People: Atlas of Our Changing Environment*. The colorful and approachable atlas presents 30 years of before-and-after Landsat satellite imagery for 80 locations worldwide, providing insights into the many ways people around the world have changed, and continue to change, the environment.

Pecora talks Landsat

Nearly 450 scientists, engineers, and remote sensing professionals attended the combined American Society of Photogrammetry and Remote Sensing (ASPRS) Fall meeting and the 16th William T. Pecora Symposium. Held in Sioux Falls, South Dakota (October 23-27, 2005), the Landsat Project was well-represented in plenaries, presentations, and poster sessions. Much discussion was held about the Landsat Data Continuity Mission, ongoing research using current Landsat 5 and 7 data, as well as data mined from the 30+ year archive. No less than 15 presentations focused on Landsat data, with numerous others that discussed Landsat data used in research projects. The social event, PrairieFest, was held at U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS), where William T. Pecora Award winners were announced.

Indian Ocean Data Purchase

For the first time in its career, Landsat 7 has undertaken an ocean-based campaign. Partially driven by mapping coastlines, islands, reefs, and other shallow water areas, this campaign has a total of over 1,400 scenes. This campaign is highly complex, with consideration needed for the broad spatial extent of the required scenes (India to Antarctica), as well as modeling and predicting cloud cover over the ocean. As usual, [Glovis](#) and [Earth Explorer](#) are the repositories for all ingested scenes, so our first ocean imagery is available for browse and purchase!

Antarctic data purchase

This Landsat 7 campaign acquires imagery over Antarctica from November through March every year. This season, the focus is on ensuring that the L7 archive has complete cloud-free coverage for the entire continent. Most of the scenes were captured during last year's campaign, but 32 scenes were still needed. As of January 3, 2006, around 20 percent of the required scenes have been acquired.

Solar Array Anomaly

On November 26, 2005, the back-up solar array drive on Landsat 5 began exhibiting unusual behavior. The solar array drive maintains the proper pointing angle between the solar array and the sun. The rotation of the solar array drive became sporadic and the solar array was not able to provide the power needed to charge the batteries. The Landsat 5 Flight Operations Team continues to investigate the solar array anomaly. Testing with the satellite is expected to take place in January 2006.

LGSOWG #34 Held

The USGS held its 34th Landsat Ground Station Operations Working Group (LGSOWG) meeting from October 31 to November 4, 2005, in the Los Angeles, California area. Participants from nine countries as well as Landsat Project team members, USGS Headquarters, and NASA staff covered topics that focused on Landsat data use in emergency response and legacy Landsat data issues. Also briefed was the initiative for a Landsat global mid-decadal study and various topics related to the performance of the spacecraft and instruments. The international partners each gave presentations on activities at their ground stations as well.

Landsat Data Continuity Mission

The results of a technical analysis to incorporate a Landsat-type sensor aboard the National Polar-orbiting Operational Environmental Satellite System (NPOESS) platforms indicated that the complexities significantly exceeded earlier assessments and made that option less suitable to the goals of both programs. It was agreed that adjustments to the current near-term strategy and development of a new long-term strategy are required in order to ensure the continuity of Landsat-type data. The recommendation was to acquire a single Landsat data continuity mission in the form of a free-flyer spacecraft to collect the required land surface data.

"The Administration has directed NASA and the USGS to team up on development, launch, and operation of a 'free-flyer' Landsat Data Continuity Mission, wherein NASA will procure an on-orbit data acquisition capability and then turn it over to the USGS to operate in order to ingest, archive, process, and distribute Landsat-type data products. By some estimates, such a capability would become operational early in 2011."

[Landsat Data Continuity Strategy Adjustment Memo](#) (December 23, 2005)

January Press Release 2006

Landsat 5 Resumes Operations

The USGS is pleased to announce Landsat 5 is back in operation. USGS and NASA engineers were able to make adjustments to operating procedures for the solar array drive mechanism that now allows the solar array to provide

enough power for the mission to resume normal operations. Consequently, acquisition operations have begun over the conterminous U.S. and the international stations will be brought on line in the coming weeks.

The solar array drive mechanism began exhibiting problems in late November 2005. The rotation of the solar array drive became sporadic and the solar array was not able to provide the power needed to charge the batteries. As a precaution, imaging operations were suspended until the problem was identified and potential solutions were evaluated and tested.

"This is good news for the global science and operational communities," said Mr. Jay Feuquay, Land Remote Sensing Program Coordinator for the USGS. "The Landsat Program has a well-established record of over 30 years of earth observations. The latest developments allow the Landsat user community to continue to rely on Landsat imagery. I am optimistic about the 'fix' applied to the solar array problem and the future operations of Landsat 5. At the same time, we are moving aggressively to develop a Landsat Data Continuity Mission that will provide Landsat data continuity."

Landsat 5, launched in March 1984, has performed far beyond its three-year design lifetime and has continued to collect global land surface coverage. Over 620,000 images, illustrating events from the Chernobyl disaster to Hurricane Katrina, have proven invaluable for identifying the impact of natural and human-induced changes. Landsat 5 and Landsat 7 together provided full global coverage of the Earth's surface.

The Landsat Program is the longest running civilian program providing vital images of the Earth's surface from space. The first Landsat satellite was launched in 1972 and since then, Landsat satellites have been providing a constant stream of moderate-resolution images. In 1999, the Landsat Program took a giant leap forward technologically with the launch of Landsat 7. The instruments on the Landsat satellites have acquired millions of images of the surface of the planet, providing a unique resource for scientists who study agriculture, geology, forestry, regional planning, education, mapping and global change research.

The Landsat Program has been a joint initiative of USGS and NASA to gather Earth resource data using a series of satellites including Landsats 5 and 7. NASA is responsible for developing and launching the spacecrafts, while the USGS is responsible for flight operations, maintenance, and management of all data reception, processing, archiving, product generation, and distribution. The primary objective of the Landsat Program is to ensure a consistent, calibrated collection of Earth imagery that can be used to scientifically measure change over decades and beyond, and support the operational agencies. Landsat's global survey mission is to repeatedly capture images of the Earth's land mass, coastal boundaries, and coral reefs; and to ensure the data acquired are of maximum utility in supporting the objectives of monitoring changes in the Earth's land surface and associated environment.

February 2006

Landsat 7 Maintains Safety of Spacecraft with Gyro Software

Landsat 7 de-powered one of its gyros on May 5th, 2004, due to indications of anomalous behavior. The spacecraft has three two-degrees-of-freedom gyros and needs two at any time to maintain attitude control. A risk assessment reported a 40 percent likelihood of another gyro failure by July 2005. A team was assembled to modify the software on board the spacecraft to operate in what is being termed Virtual Gyro (V-Gyro) mode. In this mode, if another gyro fails, the attitude control system would use the remaining gyro, along with existing onboard instrumentation and new control logic, to maintain attitude control.

As of February 1, 2006, the Landsat 7 team developed and uploaded flight software that can act like a "virtual" gyro -- ready to use if another gyro fails. The enhanced capability was designed, developed, tested, and implemented with no interference to ongoing Landsat 7 operations.

Zeiler Selected as EROS Remote Sensing Systems Team Lead

Tracy Zeiler was selected as the Remote Sensing Systems team lead for EROS. This team is responsible for operations of Landsat 5 and 7, the development of ground systems for the upcoming Landsat 8 follow-on mission, and other remote sensing projects. Tracy will supervise the government staff working on these projects and provide daily programmatic oversight and support. Tracy started at EROS in 1998 working on the AmericaView project. She then transitioned to Landsat as the Mission Management Officer and most recently served as the Landsat Project Manager.

Landsat 5 Returned to Operational Status

The solar array drive mechanism on Landsat 5 began exhibiting problems in late November 2005. In early January, the Landsat 5 Flight Operations Team ran a series of tests on the array drive to assess the working status of the drive system. These tests determined that the standard 1-omega rotation speed (orbital rate) of the array is no longer reliable. The good news is that the 2- and 3-omega rotation speeds appear to operate normally. Beginning January 13, the ground station at the Center for Earth Resources Observation and Science (EROS) resumed daily collection of data over the U.S. The Landsat Project declared the data as nominal and the Landsat 5 mission officially returned to operational status on January 20th. All International Stations were returned to operation by January 27th.

Only weeks after the returning to service, two Landsat 5 images show the nearly 11,000 acres affected by the Sierra fire in Orange County, California. The image on the left was acquired February 3rd, three days prior to the breakout of the fire. The image on the right was acquired February 12, on the day the fire was contained. The burned areas show as the deep red tones in the center of the image.

Landsat Research at the Upcoming Association of American Geographers Annual Meeting

The Association of American Geographers Annual Meeting hosts over 4,000 scientists from around the globe. This year's meeting will be in Chicago, Illinois, April 7-11, 2006. The meeting includes plenary sessions, field trips, and up to 74 concurrent sessions. It will include over 30 entire sessions devoted entirely to remote sensing (over 150 papers), and over half of those have at least one paper that focuses on Landsat data.

In addition to these more traditional studies using Landsat imagery, numerous other papers use Landsat data as an ancillary source. Landsat data are the backbone for much of the research being presented. For registration and additional information, go to <http://www.aag.org>. Make sure you stop by the Landsat and USGS booths in the exhibit hall!

Texas Wildfires

Landsat 7 data, acquired within days of major wildfires in central Texas, illustrate the extent of fire damage from the the first major wildfires in the U.S. in 2006.

Two major wildfires broke out in the San Angelo region on January 1, 2006 and were contained within days. Landsat 7 coverage, acquired on January 6 shows the fire scars in deep red tones, each of which is larger than 40,000 acres. The 'Rocker B' and 'Cole' fires are named for large cattle ranches they affected. The Rocker B fire area also was within the boundaries of major U.S. oil fields. Fires have long been a part of these landscapes.

March Special 2006

22 years and Still Ticking -- Landsat 5 Beats Expectations

The Landsat 5 satellite, launched on March 1, 1984 has completed 22 years of record-setting Earth observations. In an era of “overnight success” and disposable products, there is no better example of dependability, economy, and achievement than the Landsat 5 Earth-observing satellite. Because of the sophisticated equipment on board, engineers anticipated a life of a mere two years, with a goal of three years of collecting data over the landmass of the planet. Instead, Landsat 5 has become the longest continuously serving observation system in the U.S. civilian fleet. The track record for this satellite is nothing short of phenomenal.

March Outgassing 2006

Landsat 5 Thematic Mapper (TM) Outgassing Event Scheduled for March 14-15, 2006

A Landsat 5 Thematic Mapper (TM) outgassing event is scheduled for March 14-15, 2006. This is a periodic maintenance event to improve mid-infrared band performance. During this time, normal operations will be suspended. Imaging will resume on March 16, 2006.

The Landsat 4 and Landsat 5 Thematic Mappers (TMs) collect imagery in seven different wavelength bands. The detectors for Bands 1-4 are located at the Primary Focal Plane (PFP), where the temperature is normally near 298 K (77 degrees Fahrenheit or 25 degrees Celsius). The detectors for Bands 5-7 are located at the Cold Focal Plane (CFP), where the temperature is maintained between 95-105 K (-288 and -270 degrees Fahrenheit or -178 to -168 degrees Celsius). This low temperature is necessary to allow for adequate detection of mid-infrared wavelengths reflected from the Earth. Due to the low temperature, condensation occurs in the form of a thin film on the window of the detector housing. The deposited film degrades CFP detector responses.

Onboard heaters can be turned on for 10 -12 hours to allow complete removal of the thin film layer from the housing window. This event is commonly referred to as the ‘outgassing event.’ When certain changes are evident in detector response, a need for an outgassing is indicated, and the Landsat Mission Control schedules this event ([Learn more](#)). The fix is temporary. When the heater is turned off to resume imaging, the thin-film begins to re-accumulate. Therefore, outgassing must be performed annually.

The thin film build-up phenomenon has not been observed in Landsat 7 ETM+. This is likely attributed to an additional detector housing window.

Landsat 5 Update March 2006

Interruption of Landsat 5 Acquisitions

An unexpected problem has occurred in Landsat 5's ability to transmit data, causing an interruption in acquisitions. Engineers are studying the problem and testing is underway. We will post updates as more detailed information becomes available.

Technical details

On March 16, 2006, the Landsat 5 X-band downlink transmitter, used to send imagery to the ground stations, turned off prematurely during a pass over the Landsat Ground Station in Sioux Falls, SD. The Traveling Wave Tube Amplifier (TWTA) tripped an Over Current Protection circuit. The transmitter experiencing the anomaly is the backup unit that has operated since the primary transmitter was powered down in 1987 due to similar issues. Imaging operations have been suspended until further notice. Testing is ongoing to determine the cause of this anomaly and options for returning to full operations.

Landsat 5 Update April 2006

Landsat 5 Resumes Operations

The Landsat Project is pleased to announce that Landsat 5 has returned to full operations. On March 17, 2006, Landsat 5 experienced a problem with its radio transmitter, preventing transmission of science data to ground receiving stations. The team expects reliable operations of data transmission for the foreseeable future.

Technical Details:

On March 17, 2006, the Landsat 5 Mission Operations Center detected an uncommanded shutdown of its X-Band data transmitter. The anomaly team determined that a power spike was occurring when the transmitter was turned on, essentially tripping a circuit breaker that shuts down the transmitter. To avoid this problem, the team devised an alternate power-on procedure that prevented the spike from tripping the breaker. The Flight Operations Team implemented this new procedure, and the Project has resumed transmission to the 13 ground stations around the world that receive Landsat 5 data.

March/April 2006

Landsat 5 Team Overcomes Problem with Solar Array

In November 2005, the rotation of the Landsat 5 solar array drive became sporadic and the solar array was not able to provide the power needed to charge the batteries. As a precaution, the team suspended imaging operations until the problem was identified. Ten months prior, in January 2005, the primary solar array drive exhibited similar problems, and the secondary drive was engaged. It is feasible that after 22 years of operations, the various lubricants are depleted or breaking down. Other mechanical issues such as the clutch slipping and wear on the teeth of the harmonic drive could also cause the array to stop functioning properly.

The anomaly team found that by increasing the torque of the motor, the array will continue to track the sun. However, the lubricant could eventually deplete further and cause added resistance that increased torque cannot overcome. Therefore, while imaging operations resumed in January 2006, the flight operations team is prepared to execute a contingency plan if the solar array drive becomes erratic in the future.

Landsat 7 Tests Bumper Mode Operations

The Landsat 7 Enhanced Thematic Mapper Plus (ETM+) instrument is currently operating in SAM (Scan Angle Monitor) mode to control the motion of the scan mirror during imaging. Over time, wear of the scan mirror assembly will cause the instrument to lose the ability to synchronize the calibration shutter with the scan mirror. Current projections show this to occur between March 2007 and January 2008. As a result, changes to operations and software are necessary to switch the instrument to an alternate mode, known as "bumper mode." The Landsat 5 Thematic Mapper underwent a similar change in 2002.

Example of Landsat 5 Calibration Shutter Image Incursion

In preparation for this event, on March 3rd and 19th, 2006, the Landsat 7 flight operations team successfully tested bumper mode operation over several geometric calibration sites. Analysis of the preliminary data show the movement of one of the antennas impacts image acquisition, but this error can be corrected by the ground processing system. Additional in-depth research is underway, but this successful bumper mode test is a positive indicator for the continuation of the Landsat 7 mission.

Landsat 5 Team Resolves Data Transmission Problem

On March 17, 2006, the Landsat 5 X-band downlink transmitter, used to send imagery to the ground stations, turned off prematurely during a pass over the Landsat Ground Station (LGS) in Sioux Falls, SD. The transmitter is the backup unit that has operated since the primary transmitter was powered down in 1987 due to similar issues. The Traveling Wave Tube Amplifier (TWTA) tripped an Over Current Protection circuit. The anomaly team determined that a power spike was occurring when the transmitter was turned on, essentially tripping a circuit breaker that shuts down the transmitter. To avoid this problem, the team devised an alternate power-on procedure that prevents the spike from tripping the breaker. The flight operations team implemented this new procedure, and on April 1, 2006, the project resumed transmission to the 13 ground stations around the world that receive Landsat 5 data.

Landsat Completes Transcription Efforts for TM Data

The Landsat Project manages the digital data archives for the Landsat missions. The project began the migration of Landsat 1-5 data in FY05 from aging media stored on shelves to more modern media in a robotic silo. Much of this

transcription (~3,500 tapes) has been completed, with the exception of a few dozen problematic tapes that will be handled manually. The MSS data archive is next to join the TM imagery in the robotic data silo, which will mark the first time in Landsat history that the entire archive can be accessed without human intervention.

Landsat 7 Data Used to Support Famine Early Warning Efforts

Scientists at Earth Resources Observation and Science (EROS) and the Geography Department of the University of California, Santa Barbara, are interpreting Landsat 7 imagery to estimate cropped area in Africa. The work supports the U.S. Agency for International Development's Famine Early Warning Systems Network, which identifies situations of food insecurity among vulnerable populations. A systematic sampling approach is taken whereby a 2 km dot-grid is superimposed on imagery and a binary crop/no crop classification is made by on screen visual interpretation. The result is an estimate of the proportion of the area cropped on a district and national scale. Since the method consists of image interpretation on a discontinuous basis, data gaps due to Scan Line Corrector-off (SLC-off) are not an obstacle. In some African countries, there is considerable uncertainty to crop production estimates, in part due to out of date figures for cropped area. Landsat estimates can reduce ambiguity, and help determine whether harvests will be adequate or will need to be supplemented by outside assistance.

LDCM Request For Proposal

The USGS, with NASA, is seeking proposals from qualified individuals to serve on the Landsat Science Team. Scientists and engineers associated with U.S. Non-Federal agencies, Academia, and Private Industry are eligible to compete for eight funded research and development contracts and membership on the Landsat Science Team. Proposals are due June 2, 2006. In addition, eight additional unfunded Landsat Science Team positions will be awarded to Federal agency and International organization scientists and engineers. Proposals for this group are due June 8, 2006.

Proposal information for the funded competition (academic, non-governmental, and industry) can be found [here](#).

Proposal information for the non-monetary competition (federal and international organizations) can be found [here](#).

June Special 2006

Landsat Data Continuity Mission Announcement

The Draft LDCM Statement of Work is now available for review and comment. Please provide comments pertaining to this [document](#) to [Patricia Dombrowski](#) by June 14, 2006.

May 2006

Photography Extends Knowledge beyond the 34-Year Landsat Archive

Approximately 28 digitized black and white photo frames from the 1950s were georeferenced and mosaicked for an area near Council, AK on the Seward Peninsula. The photo mosaic, when compared to Landsat images from 1975 and 2000, is expected to extend our pre-Landsat era understanding of surface water change due to global climate change impacts on Arctic permafrost. A small scale overview of the 1950 photo mosaic, with the 2000 Landsat scene as a background, is provided in this figure.

The Gemini mission (1965-1966) set the U.S. solidly at the front of the manned spaceflight effort. An assessment of images from Gemini flights was conducted to determine if the photos could be used for general science information content. Primary consideration was given to the ability to use traditional manual photo interpretation techniques. Interpretability comparisons were made relative to the Earth Resources Observation and Science (EROS) Landsat Enhanced Thematic Mapper Plus (ETM+) Pan Merged image product for the same geographic area in New Mexico.

The Gemini photography appears useful for making general land cover assessments, as well as for limited classification of water depth and turbidity. Although Landsat is the preferred imagery for analysis, the Gemini mission extends land change analysis from Landsat's archive (34 years) to 42 years.

Landsat 7 Archive Migration

All Raw Computer Compatible (RCC) and archive processed (Level 0 Reformatted Archive (L0Ra)) digital Landsat data are stored on tape media using an old UNIX Tape Archiver (TAR) format as the primary source for preservation. On May 3, 2006, the Landsat Project completed the migration of over 705 RCC and 1239 L0Ra Landsat 7 tapes (350 TB) from a proprietary TAR format to an open-source TAR format on 9940B tape media. This migration was necessary to allow the move of the Landsat Archive Manager from an SGI IRIX operating system to a Linux-based PC system, which will provide greater platform independence and more flexibility as the Landsat ground system architecture evolves. These and similar activities are important to the long-term preservation and continued accessibility of the Landsat archive.

Landsat 10-m Antenna Maintenance

In May, a vendor completed routine maintenance on the 10-m antenna located at the EROS Landsat Ground Station (LGS) in Sioux Falls, S.D. This 10-m antenna is critical in supporting both the Landsat 5 and Landsat 7 missions for downlinking wideband scientific data and for the transmission and receipt of narrowband Telemetry, Tracking, and Control (TT&C) communications.

The 10-m has supported, on average, five downlinks and five TT&C sessions per day for the Landsat 7 mission since its launch on April 15, 1999. In 2001, the U.S. Geological Survey (USGS) took responsibility for Landsat 5 mission operations, including TT&C and science data downlinks, which also utilize the 10-m capabilities at the LGS.

During the visit, the vendor rated the antenna in very good condition with the exception of its high power amplifier. This device boosts the transmitted signal sent to the spacecraft. It is currently operating at minimum acceptable power levels and options are being examined to remedy the problem. Contingencies do exist for this critical functionality, including a 5.4-m antenna at the LGS for AmericaView activities, as well as a cooperative arrangement with NASA to support TT&C using their deep space network.

The Research of the Landsat Community

The Landsat user community has been described as being a mile wide, but an inch deep. To explore how Landsat data are being used, the EROS librarian, Carol Deering, compiled a list of all 2005 journal articles with Landsat in the title or keywords. The resulting list included over 1,000 articles, and undoubtedly more articles exist with Landsat data playing a more minor role.

To get a sense of the research areas where Landsat is used, staff collapsed this list of journal articles into general categories based on journal title. They were surprised by the diversity of research areas where Landsat is an important data source, particularly in the biological sciences.

The category of Remote Sensing includes only 9 journals, but they represent 329 articles (an average of 37 Landsat articles per journal for 2005). The other categories combined include 318 journals, with 684 articles (2 Landsat articles per journal for 2005).

The presence of Landsat data in places such as Coastal Management and The Journal of Biogeography demonstrates that the Landsat archive is being exposed to an audience that may not otherwise use remotely sensed data as a research tool. The USGS, the Geography Discipline, the Land Remote Sensing Program, and the Landsat Team are proud to contribute to such a wide breadth of research.

Partners from 12 Countries Attend the 15th Landsat Technical Working Group Meeting

USGS held its 15th Landsat Technical Working Group meeting in Sweden from May 15-19, 2006. The meeting was hosted by the European Space Agency and the Swedish Space Corporation at the Esrange Space Center in Kiruna, Sweden. Participants from 12 countries, including members of the USGS Landsat project and NASA staff, discussed topics that focused on satellite technical issues, global Landsat data sets, catalog interoperability, other technical issues, and future plans. Each station briefed technical status of their systems and provided information regarding archive holdings and data distribution. The Thailand delegation presented information about the Thailand Earth Observation System (THEOS) satellite that is scheduled to launch in 2007.

Hot Topics at the ASPRS Annual Meeting

At the annual meeting of the American Society of Photogrammetry and Remote Sensing (ASPRS), held in May 2006, "Hot Topics" sessions were devoted to the Landsat Data Continuity Mission (LDCM), both in the long- and short-term. One session, chaired by NASA's Ed Grigsby, focused on the Future of the Land Imagery-Interagency Working Group. The discussion centered on a current effort to present a report to the Office of Science and Technology Policy at the White House to influence the future of Landsat-like missions. The Working Group is collecting user feedback and opinions on the following areas:

- What does Landsat contribute to society? (What are the societal benefits?)
- Why do we need moderate resolution imagery?
- What are the options for development and ownership?
- How should US land imaging be managed?

If interested, please visit www.landimaging.gov or e-mail your opinions and views to survey@landimaging.gov.

The second session was chaired by Tom Loveland (USGS) and focused on LDCM. Concerns about the inclusion of a thermal band in the next mission were discussed, as well as user-community support for follow-on missions. The audience expressed the desire that the U.S. should remain a leader in the international Land Imaging community.

Jay Feuquay

It is with great sadness that we inform you of the passing of our dear friend and colleague Jay Feuquay after several months of illness.

Jay came to EROS in 1981, working as contract staff in the Science and Applications Branch. Many of you first met him in 1999 when he became an official U.S. Geological Survey government employee as the Landsat Project Acquisition Manager and then the International Coordinator. In 2003, Jay moved from Sioux Falls, South Dakota to the USGS headquarters in Reston, Virginia to become the Land Remote Sensing Program's National Coordinator. In this role, Jay worked tirelessly to promote the use of remote sensing data to solve the challenges of the USGS and successfully championed the continuity of Landsat-class Earth observations into the future with the USGS at the helm.

Jay is best remembered for his intellect, his determined efforts to promote and improve the remote sensing program within the USGS, his wit, his ready smile with friends and his love for his family. He will certainly be missed.

Input Needed 2006

Landsat Users – Your input is needed

In December 2005, the U.S. Government, under direction of the National Science and Technology Council (NSTC), began a multi-agency effort to better define the Future of Land Imaging in the United States. The Office of Science and Technology Policy (OSTP) called on the NSTC to form the Future of Land Imaging - Interagency Working Group (FLI - IWG) to “develop a long-term plan to achieve technical, financial, and managerial stability for operational land imaging in accord with the goals and objectives of the U.S. Integrated Earth Observation System (IEOS).”

To ensure the broadest possible input into the FLI - IWG process, the American Society for Photogrammetry and Remote Sensing (ASPRS) developed a survey so that the professional user community can provide useful input into the deliberations.

As a Landsat user, you are encouraged to respond to this survey. Your response will provide valuable information to ASPRS as it supports the effort to “operationalize” moderate resolution satellite land-imaging by the United States.

The ASPRS questionnaire can be found at: <http://www.surveymonkey.com/s.asp?u=99782258161>

June/July 2006

Landsat Research Citations: 1999-2005

Last month's newsletter included an update on Landsat journal article citations in 2005. We wondered how it would change over the lifetime of Landsat 7. Building on the work for 2005 citations, we included 1999-2004 in our analysis, collapsing over 5,000 articles into the same categories based on journal title. This is what we found:

- The overall number of references to Landsat has steadily increased - from 855 in 2003, to 929 in 2004, to 1003 in 2005 - which we thought was very good news.
- Results showed that Landsat citations in some research areas, such as biology/ecology, have been on the rise since 2002.
- Remote sensing and geography references have been climbing steadily as well.
- Earth science and geology references are showing a steady decline since a peak in 2002.
- Engineering and IT references show no clear pattern of growth or decline.

What is causing these trends? Will they continue? The Scan Line Corrector (SLC) failure in 2003 likely affected the trend somewhat. However, there is the complicating factor of time – it takes years to do scientific research and get the results published. A research lag time is certainly hidden in these statistics.

Regardless of the drivers of these trends, we have a six-year database that we can use to help answer questions about how people use Landsat imagery. We will continue our search back through time while watching the next years unfold.

Each of the categories is a rollup of several subcategories. For more detailed information on this literature research, please contact Ann Krause at akrause@usgs.gov

Landsat Data Continuity Mission (LDCM) Invites Feedback on Procurement Documents

U.S. Geological Survey (USGS) and NASA are working together to complete the Landsat Data Continuity Mission (LDCM) Request for Proposal (RFP), expected to be out later this year. NASA has posted several draft procurement documents on their web site for comment from potential vendors. The primary purpose for doing the review is to get feedback from potential vendors on the project, but anyone can submit comments simply by e-mailing the point of contact indicated for the document.

Several documents were released for feedback on the NASA LDCM web site, including:

- *Space Segment Requirements* and the *LDCM Lexicon*, released for comment on June 15, comments due by June 28.
- *Special Calibration Test Requirements*, released June 16, comments due June 23.
- *Space to Ground Segments Interface Requirements* and the *Mission Operations Element Requirements*, released June 20, comments due July 3.
- *Imagery Requirements supplement for the thermal imaging option*, released June 22, comments due June 30.

Once NASA and USGS finish incorporating comments on the individual documents, we will prepare a draft of the complete LDCM Request for Proposal. We will then release it for comment, and finally release the final proposal for vendors to bid on. Watch the [LDCM Homepage](#) for complete details on the RFP sections, the draft RFP, and important dates.

Landsat 7 Hawaii Image

The Landsat 7 image of Hawaii's Pearl and Hermes Atoll ([Holoikauaua](#)), available on the NASA web site, shows a land area of less than ½ square mile, but over 450 square miles of coral reef. The atoll is one of over a dozen shallow-water areas that were recently incorporated as the Northwestern Hawaiian Islands National Monument.

Image Credit: NASA

http://www.nasa.gov/vision/earth/lookingatearth/coral_assessment.html

Wildfire and Landsat

The Forest Service and the Department of the Interior (DOI) use Landsat data to assess vegetation and soil after a fire. Vegetation is compared both before and after the fire in pre- and post-fire images. A differenced Normalized Burn Ratio (dNBR) is calculated, which is a ratio of the greenness of the images. The dNBR is then used to create a Burned Area Reflectance Classification. These data are delivered to field BAER (Burned Area Emergency Response) teams as they assess the post-fire vegetation and soil effects. The satellite-derived product saves the BAER teams days of time and thousands of dollars, and increases accuracy. Landsat is the ideal sensor for such a job and is the most frequently used sensor for this process.

Landsat 5 Receives AIAA Award

The USGS Landsat 5 Flight Operations Anomaly Team has been selected by the American Institute of Aeronautics and Astronautics (AIAA) to receive the International Space Ops Award for Outstanding Achievement for 2006.

The team, led by USGS Flight Systems Manager Ronald Smilek, will receive the award at the 9th International Conference on Space Operations in Rome on June 19-23. Quoting the citation, the USGS team will receive the award “for dedicated efforts in recovering Landsat 5 from two potentially mission-ending hardware anomalies and restoring the mission to full operations.” In November 2005, the solar array that generates power for Landsat 5 stopped working properly; in March 2006, the downlink transmitter that sends image data to ground stations tripped a circuit breaker and stopped transmitting data. In each case, the Flight Operations Anomaly Team was able to devise corrective procedures and restore the 22-year-old Landsat 5 spacecraft to full operations. As a result of the team's efforts, image data from Landsat 5 continue to be available to scientists around the globe.

With more than 31,000 members, [AIAA](#) is the world's largest professional society devoted to the progress of engineering and science in aviation, space, and defense.

Landsat Raydome Dedicated to Friend and Co-worker Jay Feuquay

As reported in a [previous newsletter](#), the USGS and the Center for Earth Resources Observation and Science (EROS) was saddened by the loss of our friend and co-worker Jay Feuquay. Jay is fondly remembered by those who worked with him at the Center, first as a support contractor who focused on new technology efforts such as the MAGIC network, and then as a government employee who played an important role in the legacy of Landsat. On May 25th, a ceremony was held at EROS to dedicate the 10m antenna and enclosure, the “Jaydome,” in honor of Jay's contributions, including his quick wit and great sense of humor.

Landsat 5 Solar Array Drive Showing Signs of Age

Landsat 5 is showing more signs of wear after its more than 3.1 billion miles traveling around planet Earth. On January 25th, 2005, the Landsat 5 solar array, the single means of collecting energy from the sun and converting it to electrical power necessary to run the satellite's systems, appeared to be not moving smoothly and sticking during its normal rotation.

It is necessary for the solar array to rotate during orbits to maintain an optimum position relative to the sun and collect sufficient energy. After this first problem, the primary drive system was declared failed and the Landsat Flight Operations Team (FOT) recommended that operations be switched to an available redundant drive system. In November 2005, the secondary solar array drive also began to show signs of sticking during rotation. It was hypothesized that as a part of the aging process, the Landsat 5 solar array drive was probably experiencing a loss of lubricant, a kind of "satellite arthritis."

This time, the FOT looked into further options and found that increased rotation rates were available, which would provide increased drive force and thereby allow the motor to overcome increasing friction. By changing the operational procedures and increasing the rotation rate to twice its normal value, Landsat 5 imaging continued uninterrupted until July 8th, 2006, when the solar array again showed signs of sticking. At that time, the FOT changed the solar array rotation rate to three times its normal value. It continues to operate at this rate. This is the last of the speed options available to the FOT, but the good news is that Landsat 5 can continue to operate at a reduced imaging rate with the solar array in a static position. The Team is currently developing plans and procedures for this mode of operation if it becomes necessary.

Landsat 5 Solar Array Update 2006

Landsat 5 Solar Array Update

When Landsat 5 experienced problems with the Solar Array Drive in January 2005, the secondary drive system was enabled. Erratic movement of the secondary array was observed in November 2005. The cause was likely increased friction due to lubrication depletion. The motor speed was increased so that the additional torque would overcome this friction. The solar array operated in this configuration until, on August 11, 2006, the array stoppage was again observed. In response to possible failure of the Drive, the Solar Array was placed in a fixed position on August 16, 2006, spacecraft 'noon,' to maximize the power charge to the batteries. Landsat 5 is currently collecting data over the U.S. and Alaska, and our International Cooperators will come back online as the power budget allows.

November 2006

These stories are featured in this month's Newsletter

- Interactive Spectral Characteristics Plotter
LDCM scientists have developed an interactive tool that helps visualize how bands of different satellite sensors measure the intensity of the wavelengths of light.

- Landsat Sales for the 2006 Fiscal Year
- The Mid-Decadal Global Land Survey
 - The U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA) have joined together to augment a series of decadal global land surveys with a new one based around the 2005-2006 time period.
- Landsat Data for International Polar Year Studies
 - Introducing the first Landsat mosaic of Antarctica. With over 1,000 scenes, it will be one of the largest mosaics of Landsat ever created.
- EarthNow! Goes Live
 - EarthNow! displays data received from the Landsat 5 and Landsat 7 satellites as they pass over the United States.
- Landsat 5 for Alaska - Successful 2006 Season
 - The multi-agency collaboration to capture Landsat 5 data for Alaska for the 2006 season was a success, with 4,780 scenes captured over Alaska, eastern Siberia, and western Canada.
- ASPRS Moderate Resolution Remote Sensing Survey Results are in!
 - 1,295 voluntary respondents participated.
- Landsat Science Team Announced
 - The team has been chosen, the announcement is out, and the first Landsat science team meeting is underway.
- L5 Solar Array Update
 - The Solar Array was placed in a fixed position, or Spacecraft “Noon”.
- New L5 Mission Operations Center Contractor Selected
- L7 Solid State Recorders
 - Recorder capacity does not significantly affect acquisitions
- Did you know?
 - GloVis (Global Visualization Viewer – glovis.usgs.gov) has a feature that allows users to upload their own shape files to display as a map layer.
- Landsat History
 - The Landsat project began in 1965. The first satellite was launched on July 23, 1972.

Links of Interest

- [USGS](http://www.usgs.gov)
- [USGS EROS](http://www.usgs.gov/eros)
- [Landsat](http://www.usgs.gov/landsat)
- [LDCM](http://www.usgs.gov/l5)