

# 2002 Landsat Updates

## January 2002

### International Ground Station (IGS) Metadata

Metadata from Canada, Australia, South Africa, Japan, and Europe continue to be archived successfully. As of January 30, 2002, there were 8,115 Landsat 7 International Ground Station (IGS) subintervals archived for 132,732 Landsat 7 Worldwide Reference System (WRS) scenes. IGS metadata from China (BJC) were released to the public on January 4, 2002. Tape ingest for IGS metadata and browse is being tested, and remains scheduled for operations during the first quarter of 2002. All IGS accessing the Distributed Active Archive Center (DAAC) IGS server are encouraged to administer their accounts (passwords) in order to maintain security.

### Data Validation and Exchange

The Kiruna, Sweden and Neustrelitz, Germany ground stations provided the U.S. Geological Survey (USGS) with Raw Computer Compatible (RCC) data for their biannual validation. The biannual validations of these two IGSs were successful.

The Kumamoto, Japan ground station is welcome as a new International Cooperator (IC). The Kumamoto station will be responsible for providing RCC and Level Zero Reformatted Distribution Product (L0Rp) data for data validation and exchange.

The Landsat Program has prepared an update to the Landsat 7 Level 0 R Distribution Product Data Format Control Book (L0Rp DFCB). The ICs will have an opportunity to review this update and provide feedback to the USGS at the 11th Landsat Technical Working Group (LTWG) meeting held in Canberra, Australia. All comments to the proposed changes to the DFCB will be expected by March 15, 2002.

### Pecora 15 Conference

The Pecora 15/ Land Satellite Information IV Conference, in conjunction with the International Society for Photogrammetry and Remote Sensing (ISPRS) Commission 1 Mid-term Symposium, will be held in Denver, Colorado on November 11-15, 2002. The theme of the conference will be "Integrating Remote Sensing at the Global, Regional, and Local Scale." Emphasis will be on the successful uses of satellite data and an examination of relevant complementary technologies. For further information, contact [www.asprs.org](http://www.asprs.org).

### EO-1 Mission

The USGS is teaming up with NASA to extend the useful life of the Earth Observing 1 (EO-1) technology demonstration satellite. National Aeronautics and Space Administration (NASA) officially completed the EO-1 mission in November 2001, but the two agencies, already management partners for the Landsat satellite program, have agreed to work together to extend EO-1 operations through February 2002 and then continue on a month-by-month basis.

EO-1 archive data and new acquisitions from two of its three prototype sensors, the Advanced Land Imager and Hyperion, can now be ordered from the USGS, with the first products slated to be shipped in early February.

Extending the EO-1 mission enables both agencies to sustain their research and development efforts while providing opportunities for the broader research community to obtain sample data over specified sites. USGS and NASA scientists believe both Landsat-like and “hyperspectral” data types from EO-1 could prove to be valuable in global land cover studies, ecosystem monitoring, mineral and petroleum prospecting, and agricultural crop discrimination and assessment, among other potential applications. No restrictions will be placed on users obtaining EO-1 products from the USGS.

Information on EO-1 data can be obtained at <http://eo1.usgs.gov>

## **SRTM Data**

In January 2002, NASA began public distribution of a limited number of small Shuttle Radar Topography Mission (SRTM) data sets covering sites of scientific interest to STRM Principal Investigators. Each data set consists of unedited digital elevation maps, images and ancillary data. As additional data sets are completed, they will be made available to the scientific community and the general public. For further information and to preview any of images log onto the NASA/JPL website at: <http://www.jpl.nasa.gov/srtm/>

## **National Geographic Society Exhibit**

A major, permanent exhibit of Landsat data, combined with other data sets, has opened at the National Geographic Society headquarters in Washington, D.C. Models of Earth’s features have been created using elevation data and Landsat 7 imagery. The models, each of which is larger than 2m X 2m, are in the Society’s Explorers Hall and are designed to give the public a better understanding of land features and the value of remotely sensed data.

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## **February 2002**

### **New Landsat 7 Program Manager**

Ms. Tracy Zeiler has been selected as the U.S. Geological Survey (USGS) Landsat 7 Program Manager. She has been the acting Program Manager since February 2001, and is replacing R. J. Thompson. Before joining the USGS EROS Data Center (EDC) staff, Ms. Zeiler worked in private industry and at the Alaska Synthetic Aperture Radar facility in Fairbanks, Alaska. She carries degrees from the University of Virginia (BSME) and Rensselaer Polytechnic Institute (MSCS) and has earned a Professional Engineering License.

### **International Ground Station (IGS) Metadata**

International Ground Station (IGS) metadata from Canada, Australia, South Africa, Japan, China, and Europe continue to be archived successfully. As of February 28, 2002, there were 8,469 Landsat 7 IGS subintervals archived for 137,663 Landsat 7 Worldwide Reference System (WRS) scenes. IGS metadata from Argentina (COA), Brazil (CUB), and Thailand (BKT) are currently being tested. Tape ingest for IGS metadata and browse is functioning, and is scheduled for operations during the first half of March. Brazil (CUB) will be the first IGS to utilize this new functionality. The USGS IGS Web pages and the Earth Observing System (EOS) Data Gateway IGS ordering link pages are in the process of being reviewed by each IGS. Several IGS have provided updated URLs, text, and logos.

# Ground Station Network

The network of IGSs provides opportunities for virtual global coverage from Landsat 7. The network of ground stations and coverage are represented in this graphic.

## Landsat 5

Over the past few months, the Thematic Mapper (TM) on Landsat 5 has experienced an occasional delay in scan mirror synchronization with the calibration shutter. The delay allows the shutter to obscure parts of the scan line during imaging. This shows up as "caterpillar tracks" in the data. While the effect is related to the age of the instrument, analysis indicates that it may be controlled by carefully maintaining the temperature of the scan mirror assembly. The Landsat 5 Flight Operations Team (FOT) is conducting tests that add heat to the payload system. This should result in eliminating the delay of synchronization

## Multi-scene Products

The Landsat 7 Level Zero Reformatted Distribution Product (LORp) and Level 1 multi-scene products are nearing availability. Final software modifications and testing are currently being conducted on both products. An April release date is expected. The LORp product will be initially available in 0.5 to 10 WRS scene equivalents, while Level 1 products will initially be available in 0.5 to 3 WRS scene equivalents. Customers will be able to select data down to the scan line, if necessary. Final pricing directives are being determined and will soon be released.

## Data Validation

The Cuiaba, Brazil ground station provided the USGS with LORp data for the scheduled biannual re-validation. These data were processed on the USGS systems and are found to be of equivalent quality to the corresponding data residing at EDC.

## Business Partners Meeting

On April 19, 2002, a meeting of the USGS satellite Business Partners will be held at the USGS National Center in Reston, Virginia. Current and potential Business Partners will meet to discuss efficiencies of the program, policy changes, and plans for future programs.

For further information, contact Paul Severson at [pseve.usgs.gov](mailto:pseve.usgs.gov) or by telephone at 605-594-6966

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## March 2002

### Caterpillar Tracks

Since February 2000, the U.S. Geological Survey (USGS) has been investigating the "caterpillar track" phenomenon that occurs when the Scan Mirror (SM) and calibration shutter do not synchronize prior to imaging. The root cause of the tracks is an increase in the SM turn around time; that is, the time that it takes for the mirror to transition from forward to backward scans.

As part of its design, the Scan Mirror strikes a pair of bumpers at the end of each scan. This wears down the surface of the bumpers over time, thereby increasing the distance that the SM travels between strikes against the bumpers, which translates to a longer travel time. It has been predicted that at some time during the instrument's life, the travel growth would increase to a point at which the Scan Mirror would not be able to establish synchronization with the Calibration Shutter.

Engineers have seen some correlation between the appearance of tracks and lower temperatures of the calibration shutter hub. During operations, a short warm up time for the Thematic Mapper (TM) has allowed the mirror and shutter to synchronize prior to imaging. During the past several months engineers were able to control the "tracks" by increasing the instrument on-time. Recently Landsat 5 has exhibited periods where this synchronization either exceeded the warm up period or did not occur at all. The Flight Operations Team (FOT) is continuing to explore adjustments in the TM operations in an effort to regain synchronization.

One such adjustment is the exploration of "bumper mode". Since launch the TM has been operated in Scan Angle Monitor (SAM) mode. In SAM mode the time during which the scan mirror directs incoming light to the detectors is tightly controlled. This results in uniform scan lengths and excellent knowledge of pixel locations. The FOT is looking into changing the configuration of the TM from SAM mode to bumper mode. In bumper mode the mirror is allowed to scan at a fixed frequency (14.1 Hz). The calibration shutter has no trouble synchronizing at this frequency; however, the variability of the scan lengths increases in bumper mode. A small amount of data will be collected over the U.S. in bumper mode. Engineers will then determine if the processing systems can be modified to produce useable images.

## **International Ground Station (IGS) Metadata**

International Ground Station (IGS) metadata from Canada, Australia, South Africa, Japan, China, and Europe continue to be archived successfully. As of March 29, 2002, there were 8,796 L7 IGS subintervals archived for 142,212 Landsat 7 Worldwide Reference System (WRS) scenes. IGS metadata from Brazil (CUB), and Thailand (BKT) were successfully tested and are ready for operations. IGS metadata from Argentina (COA) continue to be tested. The USGS IGS Web pages and the Earth Observing System (EOS) Data Gateway (EDG) IGS ordering link pages are in the process of being reviewed by each IGS, and several have provided updated URLs, text, and logos.

## **Data Validation and Exchange**

In the month of March the biannual revalidations were successfully completed for the Cordoba, Argentina (Raw Computer Compatible (RCC)); Maspalomas, Spain (CC); Hobart, Australia (Level Zero Reformatted Distribution Product (LORp)); Alice Springs, Australia (LORp); and the Beijing, China (LORp) ground stations. The Ulaanbaatar, Mongolia stations provided the USGS with LORp data that were validated to be of equivalent quality to the corresponding USGS data. The Alice Springs, Australia and Beijing, China stations provided the USGS with RCC data that were successfully validated. At this time there are 16 of the 18 IGSs validated using either the RCC or LORp data format.

## **Business Partners Meeting**

On April 19, 2002, a meeting of the USGS satellite Business Partners will be held at the USGS National Center in Reston, Virginia. Current and potential Business Partners will meet to discuss efficiencies of the program, policy changes, and plans for future programs. For further information, contact Paul Severson at [pseve.usgs.gov](mailto:pseve.usgs.gov) or by telephone at 605-594-6966.

## **Landsat Technical Working Group (LTWG) Meeting**

The USGS and National Aeronautics and Space Administration (NASA) are hosting a joint technical/policy meeting during the week of June 17-21, 2002. The meeting, which will be held in Denver, Colorado combines the twelfth Landsat Technical Working Group (LTWG) meeting with a special meeting between the Landsat International

Cooperators (ICs) and the recently selected Landsat Data Continuity Mission (LDCM) formulation phase contractors. LTWG-12 will take place during the first half of the week. The balance of the week will be devoted to Landsat Data Continuity Mission (LDCM).

## **LTWG-11**

Landsat Technical Working Group meeting number eleven (LTWG-11) was held in Canberra, Australia the week of February 4-8, 2002. Representatives from eight of the ten International Cooperators attended. The attendees were welcomed by Peter Holland, General Manager of the National Mapping Division (formerly Auslig) of the newly organized Geoscience Australia. Other highlights included presentations by USGS on the status of both Landsat 5 and Landsat 7, reports from the International Cooperators on their product generation systems, and discussions on the CCSDS archive data format and standards for DVD media as they relate to product distribution.

## **Landsat Data Continuity**

NASA, in partnership with the USGS, has selected two proposals for further development in response to a solicitation to provide the U.S. Government with Landsat-type data that will continue the rich 30-year heritage of the Landsat series of Earth-observing missions.

The companies selected for further proposal development are Resource 21 of Englewood, Colorado, and DigitalGlobe of Longmont, Colorado. During the first phase of this fully and open competition, prospects will have approximately nine months to further develop their technical and business plans, as well as a preliminary design of their system for providing future Landsat-quality data. During this formulation phase, prospects will conduct activities such as trade studies and analyses.

For further information about the Landsat Data Continuity Mission, please see:

<http://ldcm.usgs.gov>

## **EO-1 Mission**

In the January issue of Landsat Monthly Update, it was announced the Earth Observing 1 (EO-1) mission had been extended through February 2002. Recent support has extended the mission through the northern hemisphere growing season. A decision will be made in the coming months on the future of the mission. Check <http://eo1.usgs.gov> for updates.

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## **April 2002**

### **International Ground Station (IGS) Metadata**

International Ground Station (IGS) metadata from Canada, Australia, South Africa, Japan, China, and Europe continue to be archived successfully. As of April 29, 2002 there were 9,760 L7 IGS subintervals archived for 160,532 Landsat 7 Worldwide Reference System (WRS) scenes. IGS metadata from Argentina (COA) were released to the public on April 19, 2002. Metadata from Brazil (CUB) and Thailand (BKT) are expected to be released soon. The U.S. Geological

Survey (USGS) IGS Web pages and the Earth Observing System (EOS) Data Gateway (EDG) IGS ordering link pages continue to be reviewed and updated.

## **Landsat 5 Status**

Based on the last series of experiments Landsat program managers have determined that the Scan Mirror Turn-Around-Time has increased past the point at which synchronization with the calibration shutter can be maintained. That is, the caterpillar tracks from the Landsat 5 data as it is currently being collected using Scan Angle Monitor (SAM) mode cannot be eliminated.

In SAM mode the Thematic Mapper (TM) reports three times (active scan start time, scan start to mid-scan time, and mid-scan to scan stop time) as the Scan mirror passes through three precisely located points (scan angles). Feedback mechanisms adjust the speed of the mirror to keep the active scan times within specification. The wear of the scan mirror bumpers over time has increased the time between forward and backward active scans (the mirror turnaround time) so much that the calibration shutter can no longer synchronize with the scan mirror and stay out of the image.

Tests have been done relying on data collected in the "bumper" mode. Initial results are very encouraging. Engineers were able to prototype a new mirror model and successfully correct for the scan-to-scan offsets observed in bumper mode data.

In SAM mode the telemetry reports the time for the first and second halves of each active scan. In bumper mode the telemetry contains values for the total scan mirror travel time between successive bumper impacts. In order to process the bumper mode data it is therefore necessary to infer the active scan time and angle information, explicitly measured and reported in SAM mode, from the bumper mode total scan time measurements and scan mirror calibration parameters. A method is being developed to use the scan times and calibration parameters from bumper mode to calculate SAM mode compatible first half/second half scan error values. It is hoped the bumper mode mirror profile will be sufficiently stable to allow acceptable geometric correction using nominal first half/second half scan error values with appropriate scan mirror model parameters.

Given the technical problem with caterpillar tracks and optimism with regard to creating useful images from bumper mode data, the Landsat program plans to change operation of Landsat 5. Beginning on April 29, 2002 the U.S. Geological Survey (USGS) will acquire all data over the U.S. in bumper mode.

## **Data Validation**

The Matera, Italy and Hiroshima, Japan stations have provided the USGS with raw computer compatible (RCC) data for their biannual revalidations. The two Canadian stations, Gatineau and Prince Albert, provided the USGS with Level Zero Reformatted Distribution Product (LORp) data for their biannual revalidation exercises. All four stations have received successful revalidation results.

## **L1 Product Certification**

The USGS has received sample Level 1 (L1) products from various International Ground Stations for initial testing of processes and procedures that will be required to support the product certification efforts.

## **Landsat Technical Working Group Meeting**

The USGS and National Aeronautics and Space Administration (NASA) are hosting a joint technical/policy meeting during the week of June 17-21, 2002. The meeting to be held in Denver, Colorado combines the twelfth Landsat Technical Working Group (LTWG) meeting with a special meeting between the Landsat International Cooperators (ICs) and the recently selected Landsat Data Continuity Mission (LDCM) formulation phase contractors. LTWG-12

will take place during the first half of the week. The balance of the week will be devoted to Landsat Data Continuity Mission (LDCM).

## **Business Partners Meeting**

Thirty-one Business Partners and Federal 'observers' met in Reston, Virginia on April 19, 2002. The meeting was designed to explore cooperative ventures and to review the Business Partner program. The Business Partners appreciated the cooperation and welcomed information on planned USGS involvement in future satellite missions. A report on the meeting will be posted on the EROS Data Center (EDC) web site in the near future.

## **Mission Management Meeting**

The 17th in a series of Mission Management meetings for the Landsat program was held at EDC on April 30, 2002. The meeting, attended by USGS and NASA representatives, offered an opportunity to review the status of spacecrafts and ground system and the activities of the Mission Office. Special attention was given to the problem of Landsat 5 (see above notes.)

## **EO-1 Extended Mission**

National Aeronautics and Space Administration (NASA) and USGS completed Phase 1 of the extended mission implementation. All the image tasking, data processing, customer interface, and production generation and distribution are being performed by EDC. NASA Goddard Space Flight Center (GSFC) provides Earth Observing 1 (EO-1) spacecraft command and control operations and on-board instrument engineering management. Imagery products from the Advanced Land Imager (ALI) multispectral instrument and the Hyperion hyper spectral sensor are being provided to customers across science and academia, U.S. Government defense department and civil agencies, and commercial industry. Mission operations are dependent on customer revenues for continued operation beyond June 30, 2002. (Editor's note: the March Landsat Monthly Update incorrectly stated the mission has been extended through the Northern Hemisphere growing season. At this time, the mission is extended only through June 2002.)

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## **May 2002**

### **International Ground Station (IGS) Metadata**

International Ground Station (IGS) Metadata from Canada, Australia, South Africa, Japan, China, Argentina, and Europe continue to be archived successfully. As of May 31, 2002, there were 10,945 L7 IGS subintervals archived for 182,398 Landsat 7 Worldwide Reference System (WRS) scenes. IGS metadata from Thailand (BKT) were released to the public on May 20, 2002. Brazil (CUB) metadata and browse are expected to be released soon. The U.S. Geological Survey (USGS) IGS Web pages and the Earth Observing System (EOS) Data Gateway (EDG) IGS ordering link pages continue to be reviewed and updated. The National Aeronautics and Space Administration (NASA) IGS Web pages are also being revised.

## Landsat 7 Star Catalog Updates

In April 2002, the Landsat 7 Flight Operations Team (FOT) successfully updated the on-board star catalog to improve the spacecraft's attitude control subsystem performance, representing three years of detailed analysis and planning. After observing a gap in predicted star transits detected by the Celestial Star Assembly, and analyzing over 61,000 star transits using an in-house developed tool, the "Star Logger", the FOT recommended to USGS management that a star catalog update was in order. The USGS Flight Systems Manager obtained the help of the NASA Goddard Space Flight Center (GSFC) Flight Dynamics group who provides the star catalog, to support the FOT in refining the catalog. By swapping out 138 stars in the original catalog with more appropriate stars, the star catalog was fine tuned to produce initial results of a 6 percent increase in transits with a 40 percent increase in beneficial transits and an 83 percent reduction in unwanted transits. The star catalog flight software update included extensive validation through modeling and simulation over a six week period to ensure a seamless transition in catalogs, resulting in no impact to on-going image acquisitions.

Catalog	Old	New	(Last Year)	(This Year)	Change	Total	Transits	Observed								
Beneficial (In Catalog)	323	451	40 percent	Unbeneficial (Total)	120	20	(83 percent)	Not in Catalog	88	3	Unpredicted	29	17	Mis-identified	3	0

## Data Validation

The Hatoyama (Japan), Cuiaba (Brazil) and Hartebeeshoek (South Africa) stations provided the USGS with data for their scheduled validations. The Hatoyama and Cuiaba stations successfully passed the Level Zero Reformatted Distribution Product (LORp) revalidation. The South Africa station provided both Raw Computer Compatible (RCC) and LORp for their initial data validation. The Hartebeeshoek station successfully passed the RCC data validation but failed the LORp segment of the data validation exercise.

At the upcoming Landsat Technical Working Group (LTWG) 12 (June 17-21) meeting in Denver, Colorado, the USGS intends to finalize the media options for data validation and exchange between the USGS and the International Cooperators. Great strides have also been made in support of the L1G Product Validation endeavor. More details will be generated and gained during the LTWG 12 meeting in Denver as well.

## Landsat 5 Status

Initial analysis of data collected in bumper mode data has been completed and the results are encouraging. A rigorous physical model to gain confidence in understanding of the system has been developed. A more simplified model that could be easily implemented in existing Landsat 5 data processing systems was also developed. Both of these models are described in detail in an Algorithm theoretical basis document that has been posted on the World Wide Web.  
<http://landsat7.usgs.gov/pdf/ATBD-BumperModel-v1-1.pdf>

Based on these results the two Landsat 5 related systems at the USGS (Thematic Mapper and Multispectral Scanner Archive Conversion System (TMACS) and National Landsat Archive Production System (NLAPS)) are being modified to implement the bumper mode correction (Scan Angle Monitor (SAM) mode emulation model).

Analysis continues of bumper mode data acquired over geometric test sites in order to understand how often re-issuing of correction parameters will be needed.



# LTWG-12

Planning continues for the twelfth Landsat Technical Working Group meeting (LTWG-12) to be held in Golden, Colorado during the week of June 17-21, 2002. The agenda includes status reports from the Landsat program and the International Cooperators. There will also be an in depth discussion on the status of Landsat 5.

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## June 2002

### Backup Mission Operations Center (bMOC)

On June 24, 2002, the Landsat 7 Flight Operations Team achieved their goal of establishing a backup Mission Operations Center (bMOC) capability in just 45 days. The bMOC, located in Columbia, MD, is the Landsat Program's fallback control center for Landsat 7 in the event operations at Goddard Space Flight Center (GSFC) are impaired. The Landsat 7 Flight Systems Manager observed a demonstration of the capability, providing U.S. Geological Survey (USGS) the assurance that the bMOC is ready to host flight operations on a moments notice. The initial capability includes commanding and realtime/playback telemetry receipt from the DataLynx/Poker Flats (PF1) site using a primary and alternate telecommunications path, mission planning and scheduling, load generation, flight dynamics product generation, and trending operations. With the help of the Data Capture and Processing Facility personnel at the USGS EROS Data Center (EDC), the Landsat 7 team has resolved security and configuration issues so that the remaining Landsat ground network stations can be added shortly. The Space Network/Tracking and Data Relay Satellite System (TDRSS) connectivity is soon to follow.

### International Ground Station (IGS) Metadata

International Ground Station (IGS) Metadata from Canada, Australia, South Africa, Japan, China, Argentina, Thailand, and Europe continue to be archived successfully. As of June 30, 2002, there were 11,487 Landsat 7 (L7) IGS subintervals archived for 190,990 Landsat 7 Worldwide Reference System (WRS) scenes. The USGS hopes to begin receiving metadata from Maspalomas, Spain; Matera, Italy; and Hiroshima, Japan very soon. The USGS IGS Web pages and the EDG IGS ordering link pages continue to be reviewed and updated. The National Aeronautics and Space Administration (NASA) IGS Web pages are also being revised.

### Data Validation

During the month of June, the Thailand ground station (BKT) provided the USGS with Raw Computer Compatible (RCC) and Level Zero Reformatted (L0Rp) data for validation purposes. The BKT RCC data was successfully validated to be of equivalent quality to the corresponding USGS data. The L0Rp data validation was not a success. The BKT station will provide the USGS with a new L0Rp product in the month of July once the corrections have been implemented.

A revision of the Raw CC Data Format Control Book was distributed to the IGSs for comment on June 18, 2002 via email. Comments are expected by July 22, 2002.

During the Landsat Technical Working Group (LTWG) 12 meeting in Denver, Colorado, the IGS representatives and the USGS agreed upon the elimination of the 8mm tape. For the purposes of data validation and data exchange, the 8mm tape media will no longer be accepted.

# LTWG-12

The twelfth Landsat Technical Working Group Meeting (LTWG-12) was held in Denver Colorado during the week of June 17-21, 2002. The LTWG is composed of the USGS, NASA and the International Cooperators (ICs) who operate the 16 Landsat 7 International Ground Stations. The purpose of the LTWG is to address technical issues associated with the reception, processing and distribution of Landsat data. Eight ICs were represented at the Denver meeting.

The meeting opened with presentations from the USGS on the status of Landsat 5 and Landsat 7. This was followed by an in-depth discussion on the USGS investigation into the utility of "bumper mode" data from the Thematic Mapper (TM) on board Landsat 5. Details of the correction algorithm and example images were presented. Each of the IC's gave a presentation on technical activities at their respective stations. Other presentations included an overview of DVD technology and a progress report from the Product Quality Validation subgroup. The final two days of the week were devoted to the Landsat Data Continuity Mission (LDCM). The IC's met with both formulation phase contractors (Resource21 and DigitalGlobe). Each company outlined their plans for LDCM and what role the international community played.

## EO-1 Mission

NASA and the USGS have agreed to extend the mission life of the Earth Observing 1 (EO-1) program through September 2002. Continued longevity of the mission is dependent on sufficient customer revenue to defray mission operating costs.

## Landsat Applications

Landsat data have been in strong demand for use in monitoring fires in the western United States. Federal, regional and state agencies have used the data to study the extent of the fire areas. Previously acquired data have been helpful for comparing conditions before and during the large fires.

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## July 2002

### International Ground Station (IGS) Metadata

International Ground Station (IGS) metadata from Canada, Australia, South Africa, Japan, China, Argentina, Thailand, and Europe continue to be archived successfully. As of July 31, 2002 there were 11,943 Landsat 7 (L7) IGS subintervals archived for 198,415 Landsat 7 Worldwide Reference System (WRS) scenes. The IGS metadata server was successfully transferred to a new SUN Blade on July 29, 2002. The revisions to the National Aeronautics and Space Administration (NASA) IGS web page have been completed.

### Landsat 7 Global Archive Landsat 7 Multi-Scene Products Now Available

Landsat 7 Level Zero Reformatted (L0Rp) and Level 1 multi-scene products are now available. Engineers at the EROS Data Center (EDC) completed system upgrades in early July and a public release occurred July 17th. L0Rp products are available in 0.5 to 10 WRS scene equivalents at a cost of \$475 for the first scene and \$200 for each additional scene. Level 1 products are available in 0.5 to 3 WRS scene equivalents at a cost of \$600 for the first scene and \$250

for each additional scene. Customers can order multi-scene products through the Earth Observing System (EOS) Data Gateway at: <http://edcimswww.cr.usgs.gov/pub/imswelcome/plain.html> and by contacting EDC User Services at 800-252-4547 or [custserv@usgs.gov](mailto:custserv@usgs.gov)

## **New Landsat Web Site**

In August, the Landsat Program will rollout a new web presence at the current URL, <http://landsat7.usgs.gov/>. The new site combines the content from the current Landsat Program and the Landsat calibration websites and reorganizes the content to simplify navigation and provide faster access. Feedback on the new site will be welcome. Please send your comments to [edcweb@edcwww.cr.usgs.gov](mailto:edcweb@edcwww.cr.usgs.gov).

## **Data Validation**

During the month of July, the Neustrelitz, Germany and Kiruna, Sweden ground stations provided the U.S. Geological Survey (USGS) with Raw Computer Compatible (RCC) data for their biannual revalidations. Data from both of these stations were validated successfully and found to be of equivalent quality to the corresponding data residing at the USGS/EDC. The Maspalomas, Spain ground station was scheduled for their biannual revalidation in July; however, they are waiting for a software update. The Maspalomas station has recently shipped their RCC data to the USGS.

Documentation and software tools are currently being created and tested in support of the L1G product validation efforts.

Development of the raw data subsetter (RDS) at the USGS/EDC is in progress at this time. Completion of the RDS is expected at the end of calendar year 2002.

## **EDC Ground Station Re-Engineering Completed**

The EDC engineering and operations staff recently completed a major, two-year ground architecture re-engineering project. The Landsat Program sponsored this re-engineering effort to accomplish several goals:

1. Lower Program maintenance costs by installing new, maintainable computer hardware.
2. Separate data capture, archive processing, and archiving functions to increase flexibility.
3. Implementing a simple, deployable capture system to support contingency capture operations.
4. Automating the archiving of Raw Computer Compatible and L0Ra data and the distribution of L0Rp data through the use of a StorageTek near line silo based system.
5. Positioning the architecture to support additional missions.

During July, the Re-Engineering Team completed final testing and operations verification activities along with a formal operations readiness review. All reengineering goals have now been met and the project has ended. The new architecture has reduced the time to prepare Landsat 7 data for archiving and customer order by 75%, along with reducing operator workload.

## **LGSOWG Meeting**

The #31 Landsat Ground Stations Operations Working Group (LGSOWG) meeting will be held in Matera, Italy, October 14-18, 2002. Please note the change in dates from previous notes.

# Earth as Art Exhibits

The USGS/NASA sponsored exhibit, "The Earth as Art: A Landsat Perspective," continues to draw general public attention to the Landsat Program. The U.S. Library of Congress has opened a permanent exhibit based on the 41 images. In celebration of the 30th anniversary of the Landsat Program, U.S. Senator Tom Daschle hosted a showing of the images in a Senate Office building, and a number of the images are being displayed at the NASA Goddard Space Flight Center (GSFC) Visitor Center.

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## August 2002

### Program Management Change

Mr. Jay Feuquay, the Data Acquisition Manager and International Coordinator for the Landsat Program, is leaving the Landsat Program at the EROS Data Center (EDC) to assume responsibility as the supervisor of the Headquarters Land Remote Sensing Program Office at the U.S. Geological Survey (USGS) National Center in Reston, Virginia.

Mr. Feuquay will also be acting as the Land Remote Sensing Program Coordinator until that position is announced and a competitive selection is made. In this capacity, Jay will represent the discipline and the Bureau to national and international communities on critical land remote sensing issues. He will report for duty in Reston on September 16th. Concerns about the Data Acquisition Manager's responsibilities and International coordination should be directed to Ms. Tracy Zeiler, Landsat Program Manager.

### International Ground Station (IGS) Metadata

International Ground Station (IGS) Metadata from Canada, Australia, South Africa, Japan, China, Argentina, Thailand, and Europe continue to be archived successfully. As of August 30, 2002 there were 12,375 Landsat 7 (L7) IGS subintervals archived for 205,617 Landsat 7 Worldwide Reference System (WRS) scenes.

### Potential Flood Monitoring

Landsat 7 data are being used to monitor a major rise in water levels in the Dongting Lake in the Hunan Province of China. Torrential rains have enlarged the lake; the second largest lake in China, creating a potential flooding zone that could affect 10 million people and 850,000 hectares of fertile farmland.

### New Landsat Web Site

The Landsat Program has released a new Web presence at the current URL, <http://landsat7.usgs.gov/>. The new site combines the content from the current Landsat Program and the Landsat calibration websites and reorganizes it to simply navigation and provide faster access. Feedback on the new site will be welcome. Please send your comments to [edcweb@edcwww.cr.usgs.gov](mailto:edcweb@edcwww.cr.usgs.gov).

### Data Validation

The Cordoba, Argentina, Hiroshima, Japan and Maspalomas, Spain ground stations have each provided the USGS with Raw Computer Compatible (RCC) data for their scheduled biannual revalidations. All three biannual revalidations were successful and are considered to be of equivalent quality to the corresponding USGS data.

The Level 1 Geometrically Corrected (L1G) product validation efforts are progressing as scheduled. Documentation, processes and procedures continue to be established and revised with significant cooperation from the International Ground Stations (IGSs).

## **LGSOWG Meeting**

The #31 Landsat Ground Stations Operations Working Group (LGSOWG) meeting will be held in Matera, Italy, October 14-18, 2002.

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# **September 2002**

## **International Ground Station (IGS) Metadata**

International Ground Station (IGS) Metadata from Canada, Australia, South Africa, China, Argentina, Thailand, and Europe continue to be archived successfully. As of September 30, 2002 there were 12,809 L7 IGS subintervals archived for 212,858 Landsat 7 Worldwide Reference System (WRS) scenes.

## **Staffing Contract at the EROS Data Center (EDC)**

A contract estimated at \$154 million has been awarded October 1, 2002 to Science Applications International Corporation (SAIC), of San Diego, Calif., for operation of the U.S. Geological Survey's (USGS's) EROS Data Center (EDC), in Sioux Falls, S.D. This is one of the largest service contracts within the Department of the Interior (DOI).

The five-year contract is for archiving, processing and distributing remote-sensing and related Earth science data; design and development of information management systems; research; and the operation of the computer and photographic libraries.

## **New Landsat Web Site Landsat Sales**

The Landsat Program has released a new Web presence at the current URL, <http://landsat7.usgs.gov/>. The new site combines the content from the current Landsat Program and the Landsat calibration websites and reorganizes it to simply navigation and provides faster access. Feedback on the new site will be welcome. Please send your comments to [edcweb@edcwww.cr.usgs.gov](mailto:edcweb@edcwww.cr.usgs.gov). In fiscal year 2002 (October 1, 2001-September 30, 2002) The USGS EDC sold over 23,000 Landsat products, representing over \$10 million in sales of Landsat 1-5, 7 data.

## **Data Validation**

The two Canadian stations, Gatineau and Prince Albert, along with the China station all provided the USGS with Level Zero Reformatted Distribution Product (LORp) for revalidation purposes. These three station's data were found to be of equivalent quality to the corresponding USGS data and have passed their biannual revalidations successfully.

The second series of Level 1 Geometrically Corrected (L1G) data have been requested from the IGS and will be used for further testing of the USGS procedures and methodology. At this time L1G data have been received from four stations. More products have been confirmed to be en route from other International stations.

## **Delta-i Orbit Inclination Adjustment**

Periodic adjustments to the Landsat satellite's orbit inclination need to be made. One cause for adjustment is force created by the Earth's equatorial bulge. This bulge imparts a force on any satellite orbit with a non-zero inclination and, in order to maintain the Landsat sun-synchronous orbit, the inclination must be tightly controlled (to less than 0.01 degree.)

Delta-i burn operations will begin on Day 281 (October 8th) and will be similar to those executed last year. Two burns will be executed, each approximately 700 seconds in duration. Each burn will be preceded by a 90.5 degree Yaw slew in order to orient the thrust jets nearly perpendicular to the orbit velocity vector. A return slew will also be executed after each burn. Two orbits will separate the burns and be used to confirm spacecraft health and safety prior to executing the second slew-burn-yaw combination.

September 200

As a consequence of the slew-burn-slew operations, the Enhanced Thematic Mapper Plus (ETM+) cold focal plane will heat above normal operating temperatures and must be cooled. During the cool down operations, calibration imaging will take place. This combined calibration/calibration operation is scheduled to last approximately 40 hours (from ETM+ cooler door OPEN) before normal imaging operations may resume.

Note: An image advisory message was sent to the IGSs on September 30th with specific non-imaging times.

## **Landsat 7 bMOC Status**

The backup Mission Operations Center (bMOC), located in Columbia, MD is the Landsat Program's fallback control center for Landsat 7 in the event operations at Goddard Space Flight Center (GSFC) are impaired.

On August 20th the Landsat 7 Flight Operations Team (FOT) achieved another milestone in the establishment of a bMOC. The August 20th testing verified the ability of the Landsat7 bMOC to support Space Network/Tracking and Data Relay Satellite System (TDRSS) contacts. Two events with Landsat 7 were completed utilizing the TDZ and TDW spacecraft, which successfully demonstrated that both Multiple Access (MA) and Single Access (SA) events could be supported from the bMOC.

During the month of September the FOT, working in conjunction with EROS Data Center (EDC)/Landsat Ground Station (LGS), refined the ftp process of transferring products to/from bMOC - LGS and re-tested LGS operationally with the satellite to verify the final bMOC configuration was successful. Ongoing testing with the Polar ground stations (Alaska and Norway) is ongoing.

The bMOC will have the ability to interface with the IGSs utilizing the same electronic product exchange (different IP address).

## **LGSOWG Meeting**

The #31 Landsat Ground Stations Operations Working Group (LGSOWG) meeting will be held in Matera, Italy, October 14-18, 2002.

# Satellite Business Partners Workshop

A one-day workshop, sponsored by the USGS, will be held November 15, 2002 for the Satellite Business Partner community (current and prospective). The workshop will be held at the Adams-Mark Hotel in Denver, Colorado, site of the Pecora 15/Land Satellite IV conference, and will cover USGS plans for the Satellite Business Partners Program, changes to the distribution or pricing of data, and new data sets or delivery systems that may assist the Satellite Business Partners. Secondly, the USGS is interested in hearing Satellite Business Partners concerns and views of market changes, again, with the view of assisting the Satellite Business partners. Contact Ronald Parsons (Parsons@usgs.gov) or, by telephone (605-594-6557.)

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## October 2002

### Delta-i Maneuver

On October 8, 2002, Landsat 7 Flight Operations performed a complex two-burn delta-inclination (delta-i) maneuver to maintain the Landsat 7 mission specification for a 10 a.m. (+/- 15 min) ascending node crossing. The delta-i is a yearly event needed to correct for orbital disturbances and keep the spacecraft in a sunsynchronous orbit on the Worldwide Reference System (WRS) 16-day repeating ground track. Coincident with the delta-i, calibration, imaging by the Landsat 7 Enhanced Thematic Mapper Plus (ETM+) instrument took place.

Two consecutive burns were executed, each approximately 700 seconds in duration. Both burns were preceded by a 90.5-degree Yaw slew in order to orient the thrust jets nearly perpendicular to the orbit velocity vector, followed by a return slew. Two orbits separated the burns to confirm spacecraft health and safety prior to executing the second slew-burn-yaw combination.

As a consequence of the delta-i operations, the ETM+ cold focal plane heats above normal operating temperatures. During the cool down operations, calibration imaging took place during a 40-hour period prior to resuming normal imaging operations. The cool down imaging helps the Landsat Science Project Office better understand the performance of the ETM+ calibration lamps. The orbit modifications, resulting from the dual delta-i, are nearly identical to the preburn predictions. Landsat 7 is positioned for another year of highly successful mission operations.

### International Ground Station (IGS) Metadata

International Ground Station (IGS) Metadata from Canada, Australia, South Africa, China, Argentina, Thailand, and Europe continue to be archived successfully. As of October 31, 2002 there were 13,294 Landsat 7 (L7) IGS subintervals archived for 220,533 Landsat 7 WRS scenes.

### Landsat 5 Bumper Mode Parameters

The Landsat Project is now posting Landsat 5 Bumper Mode calibration parameters on the Landsat web site at <http://landsat7.usgs.gov/cpf/15/index.html>. These parameters are used to process Landsat 5 Bumper Mode data and are described in the Landsat 5 Bumper Mode Algorithm specification located at <http://landsat7.usgs.gov/resource.html>. These parameters will be updated and posted to the Landsat web site on a monthly basis for users to download.

## **Data Validation**

The Alice Springs, Hobart Australia, and Hatoyama, Japan ground stations provided the U.S. Geological Survey (USGS) with Level Zero Reformatted Distribution Product (L0Rp) data for their biannual revalidations during the month of October. All validation exercises were successful and the data were found to be of equivalent quality to the corresponding USGS data.

The USGS is responsible for providing the IGS with data for validation purposes on an annual basis. In October eleven IGS were shipped an L0Rp scene, found in their acquisition circle, on CD from the USGS. At this time China has responded that they processed the USGS L0Rp data to a Level 1 Geometrically Corrected (L1G) product successfully.

## **8mm Tape for Product Distribution**

Due to low demand and technical issues associated with 8mm tape usage, the Landsat Project is evaluating the elimination of 8mm tape based products from the Landsat 7 product line. Landsat Program management staff are interested in understanding if customers would like to receive 8mm based Landsat 7 products into the future before making a final decision on this issue. Please send your comments to Rynn Lamb at [lamb@usgs.gov](mailto:lamb@usgs.gov) by November 29th if you would like EROS Data Center (EDC) to continue offering 8mm tape as a media option for Landsat 7 products.

## **31st Landsat Ground Station Operators Working Group Meeting**

The 31st Landsat Ground Station Operators Working Group (LGSOWG) meeting was held in Matera, Italy the week of October 14th. Representatives from all ten Landsat 7 International Cooperators (ICs) were in attendance. Participants enjoyed a full week of technical presentations and discussions, a tour of the European Space Agency's Matera Ground Station operated by Telespazio, and the opportunity to interact informally during evening events in the Matera area. Among the meeting highlights were presentations by Landsat Data Continuity Mission (LDCM) formulation contractors, Resource 21, and Digital Globe, on their plans to provide LDCM data to the ICs. A special note of thanks goes to the hosts at the European Space Agency (ESA) for a well planned and executed event. A CD-ROM will soon be mailed to all participants containing the presentation materials and meeting minutes.

## **Satellite Business Partners Workshop**

A one-day workshop, sponsored by the U.S. Geological Survey, will be held for the Satellite Business Partner community (current and prospective) on November 15, 2002. The workshop will be held at the Adams-Mark Hotel in Denver, Colorado, the site of the Pecora 15/Land Satellite IV conference. The meeting will cover USGS plans for the Satellite Business Partners Program, changes to the distribution or pricing of data, and new data sets or delivery systems that may assist the Satellite Business Partners. Secondly, the USGS is interested in hearing Satellite Business Partners concerns and views of market changes with the view of assisting the Satellite Business partners. Contact Ronald Parsons ([parsons@usgs.gov](mailto:parsons@usgs.gov)) or by telephone (605-594-6557.)

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# November 2002

## Landsat 7 Team Recognition

The 2001 William T. Pecora Group Award was presented to the Landsat 7 Team at the Pecora 15/Land Satellite IV symposium held in Denver, Colorado. The citation noted: "The Landsat 7 satellite mission is realizing a long-held dream for the entire Landsat Program: to have continuing seasonal, global, high-resolution data for a myriad of important science and applications uses." Accepting the award on behalf of the National Aeronautics and Space Administration (NASA) and Department of the Interior teams were Dr. Darrel Williams, NASA and Mr. R. J. Thompson, U.S. Geological Survey (USGS).

## International Ground Station (IGS) Metadata

EDC began archiving metadata from Matera, Italy (MTI) on November 27, 2002. IGS Metadata from Canada, Australia, South Africa, China, Argentina, Thailand, and Europe continue to be archived successfully. As of November 30, 2002 there were 13,518 Landsat 7 (L7) International Ground Station (IGS) subintervals archived for 223,721 Landsat 7 Worldwide Reference System (WRS) scenes. Any IGS interested in submitting browse images electronically (using FTP) has been asked to contact EROS Data Center (EDC).

## 100,000 Orbits for Landsat 5

On December 17, 2002, Landsat 5 will have reached 100,000 orbits. Each orbit is nearly 100 minutes, which equates to 19 years, 9 days, 10 hours, and 40 minutes of flight time for this spacecraft. This is a landmark in the program that surpasses even Landsat 4 since quality 30m Remote Sensing data is still being downlinked.

Traversing from orbit 99,999 to orbit 100,000, introduces some engineering challenges, similar to the Y2k scare that was faced going from year 99 to 00. The spacecraft onboard chronometers never exceed 367 days in a calendar year, and, therefore, are unaffected by this milestone. The ground system, however, was designed for a 5 year mission (30,000 orbits) or a maximum 5 digit orbit number. On December 17, 2002, the orbit numbers in all of the ground processing system will roll over from 99,999 to 00,000 which, if left alone, would disable the Landsat 5 Ground System.

Two years prior, Landsat 4 reached this milestone. A major rewrite of the ground system was undertaken at that time which resulted in a smooth transition between the 5 digit and 6 digit orbit. The work done for Landsat 4 was mapped for this eventuality on Landsat 5. The Landsat 5 Flight Operations Team (FOT) has completed the ground system modifications and is ready for this event.

## Data Validation

The Matera, Italy ground station provided the USGS with Raw Computer Compatible (RCC) data that were successfully processed and revalidated to be of equivalent quality to the corresponding USGS data. The Cuiaba, Brazil ground station provided the USGS with Level Zero Reformatted (L0Rp) data that were also successfully revalidated to be of equivalent quality to the corresponding USGS data.

## Landsat 5 Inclination Maneuver

On December 10, 2002, an inclination maneuver will be performed on Landsat 5. Landsat 5 has a Mean Local Time (MLT) requirement of between 9:30 am and 10:00 am. Current projections show that Landsat 5's MLT will reach 9:30 am in October of 2003. Due to the success of the Thematic Mapper's (TM's) transition from Scan Angle Monitor Mode to Bumper Mode and a favorable fuel projection analysis, the Landsat 5 mission has been projected out to 2008. The

December 10, 2002 maneuver will keep Landsat 5's MLT above 9:30 am until September 2006. It is expected that if Landsat 5 and its TM continue to perform well, another maneuver in 2004 will be necessary to keep Landsat 5 above 9:30 am through 2008.

Due to the intermittency of the Earth Sensors on Landsat 5, they cannot be used to maintain attitude control while the gyros are configured to the high rate for the inclination maneuver. Instead, the gyros will be placed directly into the high rate without any attitude control "safety net". This procedure has been proven on Landsat 4 but requires additional time for the spacecraft attitude to become stable. Taking this into account, the inclination maneuver will cause a cessation of imaging activities of about 3.5 days surrounding the maneuver.

Since the spacecraft will be down for slightly more than three days, an Outgas of the TM will be performed. Internal heaters will be enabled for approximately 14 hours to burn off contaminants with a 24-hour cool down period. The Outgas procedure will be completed within the inclination window so as not to lengthen this down period.

## **LTWG-13**

The Landsat Technical Working Group #13 (LTWG 13) meeting will be held in Cordoba, Argentina on March 31-April 4, 2003.

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# **December 2002**

## **100,000 orbits for Landsat 5**

Last month, the Landsat Monthly Update reported the 100,000th orbit of Landsat 5. Some of the detailed calculations in that report were incorrect. Here is the correct statement.

Landsat 5 was launched on March 1, 1984; therefore, as of January 3, 2003, it has been in service for 18 years and 307 days or nearly 19 years.

Landsat 5 achieved 100,000 orbits on the morning of Dec 19, 2002.

Additionally, a scene from the 100,000th orbit has been processed and is included to mark the historic success of Landsat 5. This scene covers the southeastern portion of Florida.

## **Ken Dolan Retires**

Ken Dolan, Senior Scientist at the National Aeronautics and Space Administration (NASA)/Goddard Space Flight Center (GSFC) and a long time advocate of the Landsat Program, has announced his retirement. Ken was a key leader in the Landsat Program and has been a major factor in the program's success. All of us in the Landsat Program are grateful for his thoughtful support and advice, and wish Ken well as he takes a well-deserved rest from government service.

# **International Ground Station (IGS) Metadata**

International Ground Station (IGS) Metadata from Canada, Australia, South Africa, China, Argentina, Thailand, and Europe continue to be archived successfully. As of December 27, 2002 there were 13,986 Landsat 7 (L7) IGS subintervals archived for 230,661 Landsat 7 Worldwide Reference System (WRS) scenes. Metadata and browse files have been received from Brazil (CUB) on 8 mm tape. These data and the 8 mm tape interface are being tested. Any IGS interested in submitting browse images electronically (using FTP) is asked to contact the U.S. Geological Survey (USGS) EROS Data Center (EDC).

## **Data Validation**

Germany and Sweden provided the USGS with Raw Computer Compatible (RCC) data for their scheduled biannual revalidations and were successfully revalidated. Level Zero Reformatted Distribution Product (L0Rp) data from the Mongolian mobile station was also received and successfully revalidated by the USGS. The Bangkok, Thailand station supplied the USGS with RCC and L0Rp data. Both the RCC and L0Rp data from the Thailand station were successfully validated and found to be of equivalent quality to the corresponding USGS data.

## **Landsat 5 Year-End Transition**

Landsat 5 Year-End Transition (YET) was scheduled for an image down period of 365:23:45:00 Z - 001:03:00:00 Z. The event was nominal. A patch that was developed to perform the YET update performed flawlessly; however, some peculiar behavior occurred within the Attitude Update Filter during the clock correction. This is a procedural problem that will be fixed by next year's YET. Once the procedure is corrected, the next YET on Landsat 5 may reduce the image down period to better than half.

## **Landsat 7 Year-End Transition**

Landsat 7 Flight Operations successfully conducted year-end operations activities to accommodate the calendar year rollover and spacecraft onboard timing issues. Imaging was suspended 24 minutes during rollover and a subsequent Earth shadow. Operations and image taking resumed with no problems encountered.

## **Landsat 7 Backup MOC**

The Landsat 7 backup Mission Operations Center (bMOC) Operations Readiness Review (ORR) was held on Dec 11, 2002 at the Datalynx facility in Columbia, Maryland. The Landsat Program deemed the bMOC is ready to fully assume operations for a minimum of 30 days should circumstances shut down the primary MOC, and directed Flight Operations to proceed with the final configuration changes to the ground network. BMOC implementation required extensive changes to nearly all of Landsat 7 flight operations interfaces including the MOC. The Landsat Ground Network sites will be phased in by mid-January, marking the final implementation steps for the MOC/bMOC.

The bMOC will be exercised on a monthly basis for planning and realtime operations. In an actual event, where USGS directs transfer of operations to the bMOC, an email notification will alert the extended Landsat 7 community, instructing them to use alternate Internet Protocol (IP) addresses and points of contact information.

## **Call for Passwords**

Landsat 7 Flight Operations is in the process of updating the IGS server passwords for all the International Cooperator (IC) users. This must be done on a regular basis to meet electronic security requirements. Their goal is to have all passwords updated by the end of January 2003. ICs should contact Landsat 7 Mission Planning as soon as possible to arrange for an update.