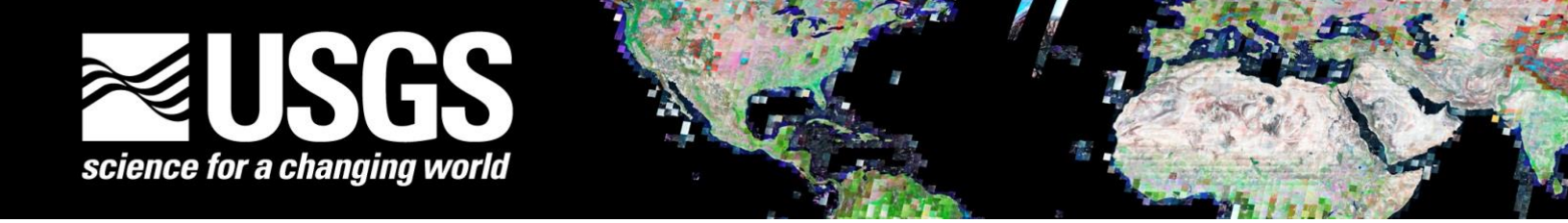

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Volume 9 Issue 5, 2015

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Note: any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Landsat Mission News

Landsat 9 to Continue Land Imaging Legacy

The USGS and NASA have started work on Landsat 9 with a planned launch of 2023. With this launch, Landsat's legacy of Earth observations will span over 50 years. NASA's press release (http://www.nasa.gov/press/2015/april/nasa-usgs-begin-work-on-landsat-9-to-continue-land-imaging-legacy) quotes Jeffrey Masek, Landsat 9 Project Scientist at Goddard: "With a launch in 2023, Landsat 9 would propel the program past 50 years of collecting global land cover data. That's the hallmark of Landsat: the longer the satellites view the Earth, the more phenomena you can observe and understand. We see changing areas of irrigated agriculture worldwide, systemic conversion of forest to pasture – activities where either human pressures or natural environmental pressures are causing the shifts in land use over decades."

Sentinel-2A Launch Successful

The European Space Agency (ESA) successfully launched the Sentinel-2A Mission on June 23, 2015 from Kourou, French Guiana, and four days later received the satellite's first images of Earth. This land-observation mission will support the European Union Copernicus Programme and play a complementary role to the existing Landsat missions. More information on Sentinel can be found at http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Sentinel-2/Sentinel-2_delivers_first_images.

Landsat 8 Data Users Handbook Available

The Landsat 8 Data Users Handbook is a living document prepared by the U.S. Geological Survey Landsat Project Science Office (LPSO) at the Earth Resources Observation and Science (EROS) Center in Sioux Falls, SD, and the NASA Landsat 8 Project science staff at NASA's Goddard Space Flight Center (GSFC) in Greenbelt, MD. The handbook serves as a reference to provide information needed by users to gain a basic understanding of the Landsat 8 observatory and science data products. The handbook is available at http://landsat.usgs.gov/documents/Landsat8DataUsersHandbook.pdf.

Additional descriptions and technical aspects of the Landsat 8 mission can be found in the Landsat 8 Level 1 Data Format Control Book (DFCB) and other documents located on http://landsat.usgs.gov/tools_project_documents.php.

Landsat Product News

Landsat 8 Thermal Scene Select Mechanism Anomaly

On December 19, 2014, anomalous current levels associated with the scene select mechanism (SSM) encoder electronics were detected on the Thermal Infrared Sensor (TIRS). Level 1 processing of TIRS data was suspended while investigations into the cause of the anomaly were conducted. On March 3, 2015, TIRS was switched from A side to B side electronics to resolve the issue with the A side encoder electronics, and this was followed by a period during which the instrument performance was characterized and validated. TIRS data processing with updated calibration files resumed on March 14, 2015, and in May 2015, all Landsat 8 scenes acquired from December 19, 2014, to March 13, 2015 were reprocessed to repopulate the inventory of Operational Land Imager (OLI) and/or TIRS data. By May 15, 2015, nearly all Landsat 8 scenes affected by the SSM had been reprocessed with valid thermal data.

More details about the TIRS Scene Select Mechanism Anomaly can be found on the May 8, 2015, Calibration Notice on http://landsat.usgs.gov/calibration_notices.php.

Level 1 Data Format Change Investigations

Currently, Landsat Level 1 (L1) products are delivered as individual bands in GeoTIFF format, compressed into a single file using 'tar' and 'gzip' functions. In order to access data files, users are required to unzip and then untar the uncompressed GeoTIFF and associated data files.

The USGS is investigating options to make data access easier for users and to become more consistent with other remotely sensed data.

JPEG2000 is being considered as the new format for Landsat L1 data products. The current GeoTIFF data files are uncompressed; the files are bundled using tar and then compressed using gzip. The plan is to store the image files compressed. The image files would then be available for download through a machine-to-machine interface and for access through web services including support for band and spatial subsetting. If downloaded through GloVis or EarthExplorer, the files would be bundled on demand using

tar. The GeoJPEG2000 images would have significantly improved compression ratios, permitting more images to be stored online and supporting faster downloads.

Two new product options have been created for evaluation and feedback. Both provide the data files in JPEG2000 (lossless compression) format with GeoJPEG2000 referencing packaged in a single file with embedded metadata. One of the options would provide metadata in an extensible markup language (.XML) file; the other delivers the metadata unchanged in an MTL.txt file.

Sample files were selected to provide a diverse overview, and utilizes common calibrations and contains Landsat 8 Combined data (both OLI and TIRS) in the following files:

1. Current GeoTIFF data files with .MTL.txt metadata file (.tar.gz – approximately 850 MB)
2. Proposed .JPEG2000 data files with current .MTL.txt metadata file (.tar – approximately 600 MB)
3. Proposed .JPEG2000 data files with .XML metadata file (_xml.tar – approximately 600 MB)

Numerous Changes to Landsat Data Planned for Fall 2015

Landsat 8 Thermal Stray Light Algorithm

Since the launch of Landsat 8 in 2013, thermal energy from outside the normal field of view (stray light) has affected the data collected in Bands 10 and 11 of the Thermal Infrared Sensor (TIRS). This stray light increases the reported temperature by up to four Kelvin (K) in band 10 and up to eight K in band 11. The errors vary throughout the scene and depend upon radiance outside the instrument field of view, which users cannot correct in the Landsat Level 1 data product.

Efforts to correct the stray light are advancing, and a mitigation algorithm is being considered for implementation in fall 2015. While this correction will not completely eliminate the errors, it may reduce them.

The amount of stray light in the scenes is estimated using scenes acquired before and after the target scene, as well as the edge pixels of the target scene. The stray light estimate is then subtracted from the target scene.

Users are cautioned that the results after this correction may still not be considered precise enough for a split-window algorithm application.

For more information see: (Montanaro, M.; Gerace, A.; Lunsford, A.; Reuter, D. Stray Light Artifacts in Imagery from the Landsat 8 Thermal Infrared Sensor. Remote Sens. 2014, 6, 10435-10456)

The metadata (MTL) will also be modified to display "**TIRS_STRAY_LIGHT_CORRECTION_SOURCE"** (this value will be "TIRS" for all LPGS products).

Phase 2 Updates to Ground Control Points

In 2014, improvements to Ground Control Points (GCPs) began. This effort, planned in phases, removes old GCPs, improves the accuracy of existing GCPs, creates new GCPs, and introduces time-specific GCPs to account for seasonal variability and major changes in the landscape through the years.

Phase 1 was completed in August 2014 and updated 171 WRS-2 paths/rows in island and coastal locations where sparse GCP coverage existed (lack of reference data in the original triangulation, few GCPs available, etc.), desert regions where shifting dunes caused existing GCPs to become obsolete, and other anomalous locations where an apparent bias remained. The new GCPs allowed scenes that once created only a systematic and terrain-corrected Level 1GT (L1GT) product to process a precision and terrain-corrected Level 1T (L1T) product. See the Landsat GCP Improvement Phase 1 Triangulation Results (http://landsat.usgs.gov/documents/about_LU_Vol_8_Issue_2b.pdf) for analysis of the paths/rows improved in Phase 1.

Phase 2, planned for fall 2015, includes updating 1,151 WRS-2 paths/rows, covering island areas and inland regions where the estimated absolute accuracy of the original Global Land Survey 2000 (GLS2000)-based ground control varied between 50-75 meters. This will update GCPs in middle to low latitude regions. Also included in these improvements are specific updates to GCPs used over Australia in order for that region to be more consistent with the Australian Geographic Reference Image (AGRI). A list of paths/rows affected is available online at http://landsat.usgs.gov/documents/Phase2_path_rows.txt.

Because the updated GCPs will be more accurate, users may want to consider re-ordering previously downloaded images. The new GCPs may allow scenes that once could only be processed to a systematic L1GT product to be processed as a precision L1T product.

CFmask Implementation Plans

The CFmask (https://github.com/USGS-EROS/espa-cloud-masking) is the planned primary algorithm for calculation of clouds, cloud shadows, snow/ice, and water in Landsat 4-5 Thematic Mapper (TM), Landsat 7 ETM+, and Landsat 8 OLI data products. Clouds will be assessed as low, medium, or high probability, or will be flagged as unassessed.

Feedback from the Landsat Science Team will be gathered during their July meeting, after which more details regarding an implementation schedule will be determined. Sample products will be made available for user analysis before this algorithm is released to operations.

More information about the CFmask Implementation Plan will be provided on the Landsat website and future Landsat Updates as it becomes available.

CFmask is a version of the Fmask cloud detection algorithm from Boston University. (Z. Zhu, S. Wang, and C.E. Woodcock, "Improvement and expansion of the Fmask algorithm: cloud, cloud shadow, and snow detection for Landsats 4-7, 8, and Sentinel 2 images", *Remote Sensing of Environment*, 159 (2015), pp. 269-277)

Land Cloud Cover Assessment to be added to Landsat 4-7 Level 1 Metadata

Cloud Cover Assessment (CCA) will provide an estimate of the proportion of land in the scene that is cloud covered. The percentage of land pixels affected by clouds will be calculated and written to the metadata file (MTL.txt) as a scene-based score in a new parameter **CLOUD_COVER_LAND.**

The land mask, used to determine land pixels included in the CCA score, is derived from the NOAA World Vector Shoreline dataset: http://shoreline.noaa.gov/data/datasheets/wvs.html.

Quality Assessment Band to be added to Landsat 4-7 Level 1 data products

Similar to Landsat 8, a 16-bit Quality Assessment (QA) GeoTIFF file will be added to Landsat 4-5 TM and Landsat 7 Enhanced Thematic Mapper Plus (ETM+) data products using CFMask. The Quality Assessment band is a created file that contains values that represent bit-packed combinations of surface, atmosphere, and sensor conditions that can affect the overall usefulness of a given pixel within a scene. A LandsatLook 8-bit Quality Band will also be created.

The Quality Assessment Band for Landsat 1-5 Multispectral Scanner (MSS) data is planned for a future release. New cloud assessment algorithms are under investigation for inclusion. The MSS QA band will be released along with the Angle Coefficient metadata.

Cirrus Cloud Cover Algorithm Update

Currently, the threshold that classifies a cloud as cirrus is adjusted based on the ground elevation using the Cirrus Cloud Cover Algorithm (CCA). The CCA uses Band 9 reflectance to detect cirrus clouds and depends on atmospheric extinction by water vapor in the band. Since cirrus clouds are so high, the light reflected from them cannot be dimmed by the thin, high-altitude atmosphere above them. This makes them appear bright over uniformly dark, low elevation terrain. Over high elevation terrain, the ground is visible in that band and the Cirrus CCA is unable to isolate the cirrus clouds.

An update to the Cirrus CCA will partially fix the high elevation terrain problem. It introduces a logarithmic dependence on elevation to the algorithm, simulating the extinction profile of water vapor through the atmosphere. This should reduce the false positive cirrus cloud detections over high elevation terrain.

Upcoming Meetings of Interest

Landsat Science Team Meeting in July

The Landsat Science Team provides technical and scientific input to USGS and NASA to help ensure the success of the Landsat program while providing science support on issues including data acquisition, product access and format, and science and applications opportunities.

The next Landsat Science Team Meeting will be held July 7-9, 2015 at the USGS EROS Center in Sioux Falls, SD. General topics include Sustainable Land Imaging, NASA-USGS Sentinel-2 Planning, and Land Cover Change. A summary will be published in the next Landsat Update.

Details about the Landsat Science Team, past meeting agendas, publications and presentations can be found at http://landsat.usgs.gov/science_Landsat_Science_Team.php.

Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) Workshop

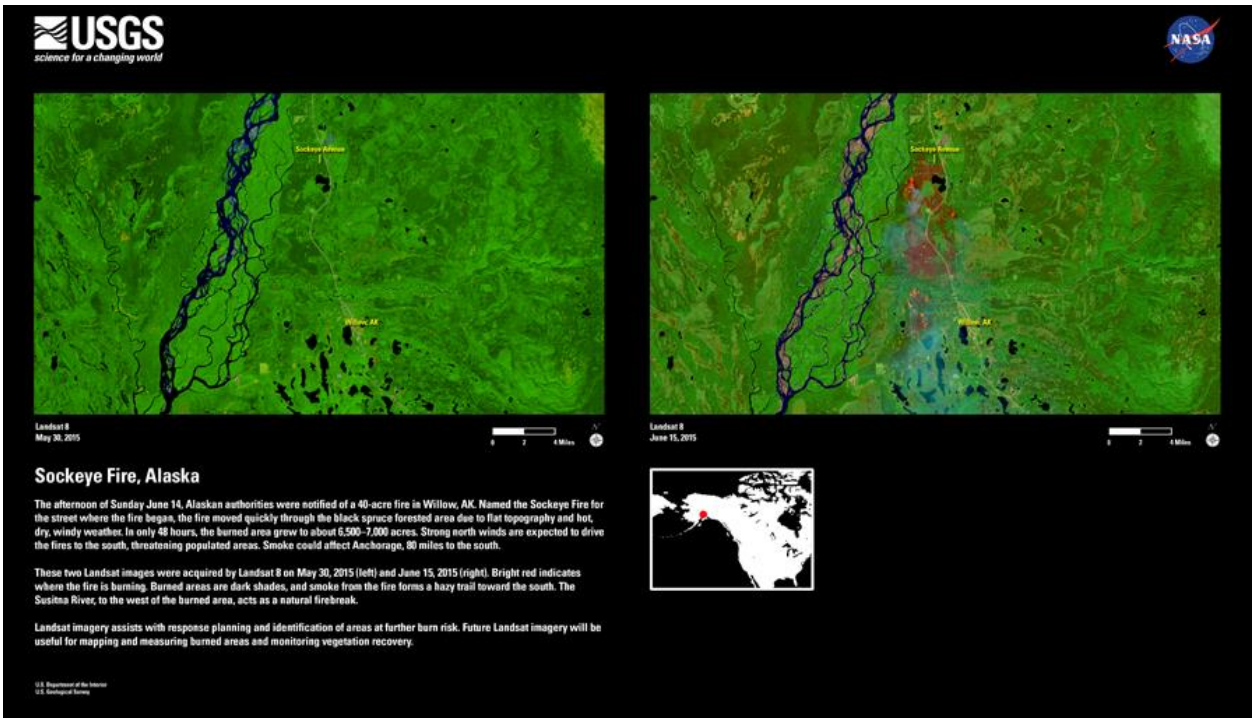
The Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) program is a coordinated effort designed to provide remotely sensed and ground truth data to understand carbon sequestration, sustainable management of forests, and land cover changes.

The 2015 Workshop will be held at the USGS EROS Center in Sioux Falls, SD, on July 20-24, 2015. This is the fifth GOFC-GOLD workshop held at EROS. This year, 10 international scientists from Bulgaria, Ethiopia, India, Togo, Madagascar, Nepal, South Africa, Uganda, Vietnam, and Zimbabwe are partaking in this venue. Participants will give presentations on current research in their field, applications, and strategies of implementation for long-term management.

While at EROS, GOFC-GOLD attendees will learn about various data products held in the EROS archives, as well as how to access the data and use it in their scientific analysis. They will download and receive several data sets (including Landsat) that will not only be used the following week when the attendees travel to Boston University in Boston, Massachusetts to learn more about analyzing the data, but also to redistribute the data to their partners when they return home.

Landsat Image of Interest

Sockeye Fire, Alaska



The afternoon of Sunday June 14, 2015, Alaskan authorities were notified of a 40-acre fire in Willow, AK. Named the Sockeye Fire for the street where the fire began, the fire moved quickly through the black spruce forested area due to flat topography and hot, dry, windy weather. In only 48 hours, the burned area grew to about 6,500-7,000 acres. Strong north winds are expected to drive the fires to the south, threatening populated areas. Smoke could affect Anchorage, 80 miles to the south.

These two Landsat images were acquired by Landsat 8 on May 30, 2015 (left) and June 15, 2015 (right). Bright red indicates where the fire is burning. Burned areas are dark shades, and smoke from the fire forms a hazy trail toward the south. The Susitna River, to the west of the burned area, acts as a natural firebreak.

Landsat imagery assists with response planning and identification of areas at further burn risk. Future Landsat imagery will be useful for mapping and measuring burned areas and monitoring vegetation recovery.

This and other interesting images can be found in the Landsat Image Gallery: http://landsat.usgs.gov.