THE LANDSAT DATA CONTINUITY MISSION OPERATIONAL LAND IMAGER (OLI) RADIOMETRIC CALIBRATION

Brian Markham, Phil Dabney,
Jeanine Murphy-Morris,
NASA/GSFC
Greenbelt, MD 20771

Ed Knight, Geir Kvaran
Ball Aerospace and Technology Corp.
1600 Commerce St.
Boulder, CO 80301

Julia Barsi
Science Systems Applications, Inc
GSFC
Greenbelt, MD 20771

The Landsat Data Continuity Mission (LDCM), a joint NASA and USGS mission, is on target for a December 2012 launch. Two sensors, the Operational Land Imager (OLI), being built by Ball Aerospace and Technology Corporation (BATC) under contract to NASA and the Thermal Infrared Sensor (TIRS), being built by NASA's Goddard Space Flight Center (GSFC), comprise the LDCM payload. The OLI is a 30 m (15 m Pan) Visible, Near-IR and SWIR push-broom sensor, covering spectral bands similar to ETM+ in this spectral region with additional bands at 443 nm and 1375 nm, for coastal and aerosol applications and cirrus cloud detection, respectively. The push-broom TIRS, with 120 spatial resolution, splits the ETM+ thermal band into two narrower "split-window" bands to aid in atmospheric correction. This paper will focus on the OLI sensor, as the TIRS radiometric calibration described in a companion paper.

The OLI includes on-board radiometric calibration capabilities of: (1) dual full-aperture full-system Spectralon diffusers, designed to be used at different frequencies to aid in tracking the system and diffuser changes, and (2) multi–bulbed tungsten lamp assemblies, that illuminate the OLI detectors through the full optical system, similarly designed to be used at different frequencies to separate lamp and system changes. The lamp system also includes two built-in silicon monitor detectors, one for each lamp assembly. The primary solar diffuser will nominally be deployed every 8 days to track the calibration of the OLI sensor and perform detector-to-detector normalization. The solar diffuser based

calibration requires a spacecraft maneuver to point the OLI solar calibration aperture towards the sun. The pristine diffuser will be used on a less frequent basis, about every six months, as a check on the primary diffuser's degradation. The working lamp set will be used daily on the OLI, the reference lamp set approximately monthly and the pristine lamp set approximately twice a year. The LDCM operational concept also calls for the spacecraft to be maneuvered every lunar cycle to view the moon, providing a "known" stable source for tracking stability over the mission. A side-slither maneuver, where the spacecraft is rotated 90° to align the detector rows with the velocity vector, is also planned. These data will provide an additional method to assess the detector-to-detector radiometric normalization.

The pre-launch radiometric calibration of the OLI will include the radiance calibration of the OLI using an integrating sphere. The traceability of the calibration of this sphere will be enhanced via a small transfer integrating sphere directly calibrated at the NIST FASCAL with this transfer sphere and the large transfer sphere checked by Ball, NASA, and NIST transfer radiometers. This radiance calibration will also be transferred to the OLI diffusers using a heliostat to provide a transfer-to-orbit standard. For the reflectance calibration of the OLI, a transfer calibration panel will be calibrated at NIST's STARR facility, including the recently available SWIR capability. The reflectance calibration will then be transferred to the flight diffusers.

The ground system, being developed by USGS, includes an Image Assessment System (IAS), similar to Landsat-7's, to operationally monitor, characterize and update the calibrations of the two sensors. The IAS will include within its capabilities the processing of raw image data (Level 0R) to fully processed (Level 1) data as used in the Landsat Product Generation System (LPGS). The data from the internal lamps, the diffusers, the lunar and side slither acquisitions will be used to assess any changes to radiometric calibration parameters and update them as necessary. Particular emphasis is on the relative detector-to-detector radiometric normalization as the OLI has about 75000 detectors. In addition to the solar diffuser and side slither techniques, statistical treatment of the data from all Earth scenes (circa 400/day) will be also used to evaluate these relative gains. Additionally, IAS algorithms will characterize: (1) the noise performance of the OLI, e.g. overall Signal-to-Noise Ratio (SNR) using the diffuser and lamp signals, coherent, 1/f, impulse and overall dark noise using the shutter data obtained before and after every acquisition interval, (2) the residual striping, banding and uniformity of the corrected imagery and (3) the stability of the instrument and data products.

As of this writing, the OLI telescope is complete and has been mated with the Engineering Development Unit (EDU) calibration assembly to begin stray light testing to be followed by integration with the EDU focal plane assembly in order to "wring-out" the spatial, spectral and radiometric testing procedures. Flight instrument level testing is scheduled to occur by conference time. Revised spectral and radiometric performance estimates should be available based on the EDU testing.

BIBLIOGRAPHY

Irons J.R., Murphy-Morris J, 2007. An Operational Land Imager for the Landsat Data Continuity Mission, IEEE International Geoscience and Remote Sensing Symposium (IGARSS), JUL 23-27, 2007 Barcelona, SPAIN, Pages: 2808-2810

Markham, B.L., Dabney, P.W., Storey, J C., Morfitt, R, Knight, E.J., Kvaran, G., and Lee, K. 2008. Landsat Data Continuity Mission Calibration and Validation, Proc. of 17th Pecora Symposium, Denver, CO., November 16-20, 2008 (on CD).

Kvaran, G., Knight, E. and Biggar, S. 2008. Pre-Launch Radiometric Calibration of the Operational Land Imager (OLI), presented at 17th Pecora Symposium, Denver, CO., November 16-20, 2008.

Morfitt, R., Markham, B., Storey. J. and Hollaren, D. LDCM On-orbit Operational Calibration and Validation, presented at 17th Pecora Symposium, Denver, CO., November 16-20, 2008.