THE LANDSAT DATA CONTINUITY MISSION OPERATIONAL LAND IMAGER: RADIOMETRIC PERFORMANCE

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The Operational Land Imager (OLI) is one of two instruments to fly on the Landsat Data Continuity Mission (LDCM), which is scheduled to launch in December 2012 to become the 8^{th} in the series of Landsat satellites. The OLI images in the solar reflective part of the spectrum, with bands similar to bands 1-5, 7 and the panchromatic band on the Landsat-7 ETM+ instrument. In addition, it has a 20 nm bandpass spectral band at 443 nm for coastal and aerosol studies and a 30 nm band at 1375 nm to aid in cirrus cloud detection. Like ETM+, spatial resolution is 30 m in the all but the panchromatic band, which is 15 meters. OLI is a pushbroom radiometer with ~6000 detectors per 30 meter band as opposed to the 16 detectors per band on the whiskbroom ETM+. Data are quantized to 12 bits on OLI as opposed to 8 bits on ETM+ to take advantage of the improved signal to noise ratio provided by the pushbroom design. The saturation radiances are higher on OLI than ETM+ to effectively eliminate saturation issues over bright Earth targets. OLI includes dual solar diffusers for on-orbit absolute and relative (detector to detector) radiometric calibration. Additionally, OLI has 3 sets of on-board lamps that illuminate the OLI focal plane through the full optical system, providing additional checks on the OLI's response[1]. OLI has been designed and built by Ball Aerospace & Technology Corp. (BATC) and is currently undergoing testing and calibration in preparation for delivery in Spring 2011. Final pre-launch performance results should be available in time for presentation at the conference. Preliminary results will be presented below. These results are based on the performance of the Engineering Development Unit (EDU) that was radiometrically tested at the integrated instrument level in 2010 and assembly level measurements made on the flight unit.

Signal-to-Noise (SNR) performance: One of the advantages of a pushbroom system is the increased dwell time of the detectors allowing for significantly higher SNR than equivalent aperture whiskbroom systems. OLI performance based on the EDU at the "typical" radiance level as specified in the OLI requirements document are about 10 times better than ETM+ performance and 2-3 times better than the requirements for OLI (Table 1).

Table 1: OLI SNR performance

Band	ETM + Band #	OLI Band #	"Typical" Radiance Level ($W/m^2sr\ \mu m$)	ETM+ SNR	OLI SNR Requirement	OLI SNR EDU Performance
Coastal/ Aerosol	-	1	40	-	130	270
Blue	1	2	40	39	130	420
Green	2	3	30	37	100	350
Red	3	4	22	26	90	260
NIR	4	5	14	34	90	240
SWIR 1	5	6	4.0	36	100	280
SWIR 2	7	7	1.7	27	100	360
PAN	8	8	23	16	80	150
CIRRUS	-	9	6.0	-	50	150

Polarization Sensitivity: OLI linear polarization sensitivity as measured on the EDU was less than 2% as compared to a requirement of 5%. Similar performance is expected for the flight unit as the EDU uses the flight telescope and the telescope is the largest contributor the system polarization sensitivity.

Detector Operability: The OLI requirements documents allows up to 0.1% of the detectors to be "inoperable" or dead, where inoperability is based on several factors including noise, stability and dynamic range. With about 6000 detectors per band, this allows ~6 bad detectors per band. All analyses to date indicate that OLI will have no inoperable or dead detectors on the flight unit focal plane. This should eliminate the need to interpolate across dead detectors and contribute to excellent image quality across the full scene.

Banding and Streaking: One of the biggest challenges for a pushbroom instrument is normalize all the detectors across the focal plane so that streaking (single detector striping) and banding (multiple detector striping) in the calibrated image products are minimized. Requirements for streaking and banding were specified in multiple ways, including full field of view uniformity, 100-pixel wide uniformity (banding) and individual pixel-to-pixel uniformity (streaking)[2]. These requirements vary from 0.25 to 0.50 % of signal. Numerous instrument design and characterizations contribute to non-uniformity including spectral uniformity, detector stability, linearity characterization and correction, dark level stability, characterization and correction, calibration source uniformity, uniformity characterization and on-orbit calibration source uniformity and uniformity characterization. Meeting these uniformity requirements has been a system driver for OLI and all specific flow-downs from systems to the design and characterization of the instrument have been met to date. Indications are that the uniformity requirements will be met in the vast majority, if not all cases.

Bibliography:

[1] 2010 Markham, B.L., Dabney, P.W., Murphy-Morris, J.E., Pedelty, J.A., Knight, E., Kvaran, G., and Barsi, J. *The Landsat Data Continuity Mission Operational Land Imager (OLI) Radiometric Calibration*, in Proc IGARSS 2010, IEEE GRSS, 4pp.

[2] 2008 Markham, B.L., Dabney, P.W., Storey, J.C., Morfitt, R., Knight, E., Kvaran, G., and Lee, K. *Landsat Data Continuity Mission Calibration and Validation,* In Proc PECORA 17, ASPRS, 7pp.