The Thermal Infrared Sensor on the Landsat Data Continuity Mission

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ABSTRACT

The Landsat Data Continuity Mission (LDCM), a joint NASA and USGS mission, is scheduled for launch in December, 2012. The LDCM instrument payload will consist of the Operational Land Imager (OLI), provided by Ball Aerospace and Technology Corporation (BATC) under contract to NASA and the Thermal Infrared Sensor (TIRS), provided by NASA's Goddard Space Flight Center (GSFC). The OLI is described in a companion paper. This paper will outline the design of the TIRS instrument and its application to monitoring water consumption by measuring evapotranspiration. TIRS calibration is addressed in a separate paper.

As is implied in the mission name, one element of the LDCM project is to provide continuity with past Landsat sensors. Another element is to provide improvements in sensors where possible. The Thematic Mapper (TM), Enhanced Thematic Mapper (ETM), and Enhanced Thematic Mapper Plus (ETM+) sensors are good examples of this philosophy as the thermal infrared band improved in spatial resolution from 120 to 60 m for the single-band, whiskbroom-approach systems (See e.g. Barsi, *et al*, 2006 and references therin). While such data have proved important in providing land-use information, volcanic and fire-monitoring data, and resource management guidance, a dual-band sensor at lower spatial resolution but with improved sensitivity would maintain continuity and provide valuable data for water resource management and agricultural studies.

The TIRS is a 100 meter spatial resolution push-broom imager whose two spectral channels, centered at 10.8 and 12 microns, split the spectral range of the single TM and ETM+ thermal band while still providing thermal band data continuity with previous Landsat missions. The

push-broom implementation increases system sensitivity. The two channels allow the use of the "split-window" technique to aid in atmospheric correction. The TIRS focal plane operates near 43 K and consists of three Quantum Well Infrared Photodetector (QWIP) arrays to span the 185 km swath width. The surface imaging telescope is a 4-element refractive lens system. A scene selecting mirror rotates the field of regard from the earth to either an on-board blackbody calibrator or a deep space view. The blackbody is a full aperture calibrator whose temperature may be varied from 270 to 330 K. Figure 1 shows a model of the TIRS instrument. As of this writing, a TIRS functional performance model is about to undergo functional and performance testing in a thermal environmental chamber.

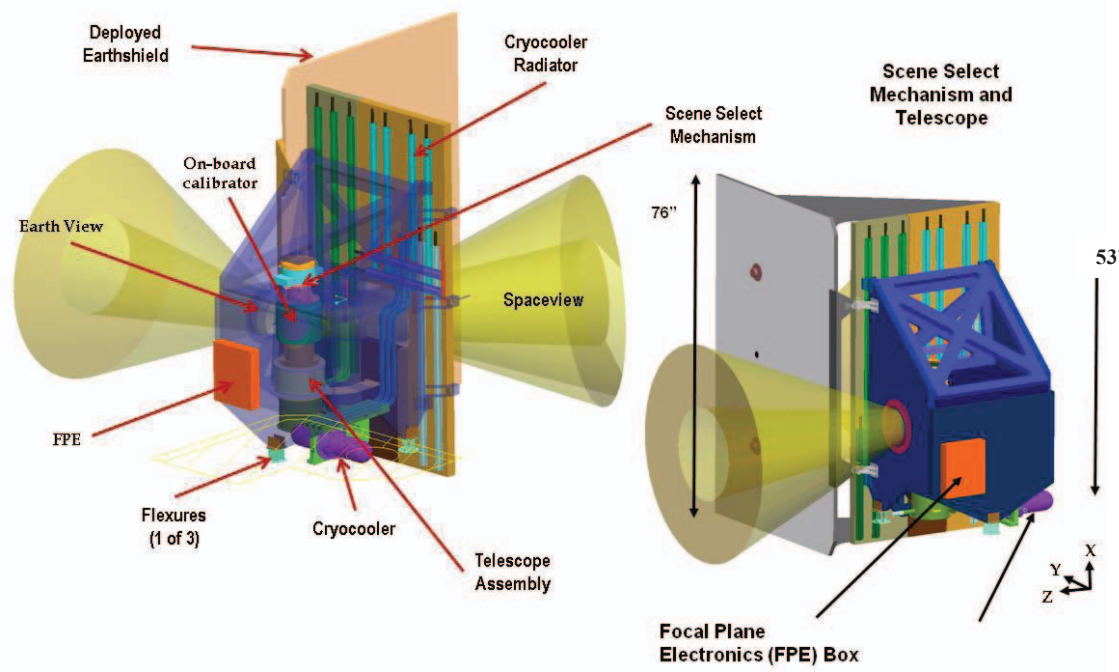

Figure 1: Model of the TIRS instrument showing the major components of the TIRS sensor. The scene select mechanism rotates the field of regard from the Earth view to either the spaceview or to the on-board calibrator.

The TIRS will be operated in concert with the OLI and data from both instruments will be merged into a single data stream. Among other uses, TIRS data will be used to measure evapotranspiration (evaporation from soil and transpiration from plants); to map urban heat fluxes, to monitor lake thermal plumes from power plants; to identify mosquito breeding areas and vector-borne illness potential; and to provide cloud measurements (see e.g. Ritchie, 1972,

Kustis *et al*, 2004, Bastiaanssen *et al*, 1998a, Bastiaanssen *et al*, 1998b) . The evapotranspiration data may be used to estimate consumptive water use on a field-by-field basis. Figure 2 shows an example of the evapotranspiration data product derived from Landsat 5 using the University of Idaho METRIC process (Allen *et al*, 2007).

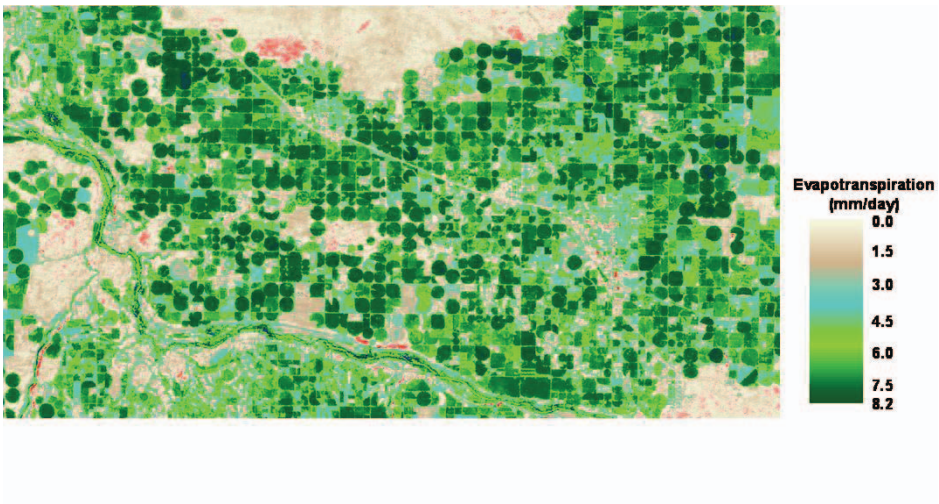

Figure 2: Evapotranspiration from Landsat 5 on July 22, 2006 from irrigated fields in the Thousands Springs area, Idaho. Round circles are center pivot irrigated fields 800 m in diameter.

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