

Landsat 4 Thematic Mapper Calibration Update

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Landsat-4 was launched in 1982 with two Earth-imaging sensors on board: The Multispectral Scanner (MSS) that had been on all previous Landsat satellites and the Thematic Mapper (TM) that was new. The TM had seven spectral bands that cover the visible (400-700 nm), near-Infrared (700-1000 nm), short-wave infrared (1000-2500 nm) and long-wave infrared (8000-14000 nm) wavelengths. About 9 months after launch in February 1983, the primary mode for sending TM data to the Earth failed. It was not until 1987 that Landsat-4 TM was again regularly used with data transmission via the Tracking and Data Relay Satellite System (TDRSS).

This major gap in the usage of the Landsat-4 TM, combined with transfer of the Landsat systems from NASA to NOAA to a commercial operator, led to a loss in understanding of the calibration of this instruments data. This calibration is required to quantify the amount of light reflected off Earth surface targets; the reflectance of the target is related to the type and amount of the target present. For example, the quantity of live vegetation relative to the background soil influences the reflectance of an agricultural field.

Using sites on the Earth surface that are extremely dry and stable, the calibration of the Landsat-4 TM was reconstructed. Only one of visible spectral bands showed significant change over the operational lifetime of Landsat-4 TM (1982-1993); this change was modeled with a smooth mathematical function. All other bands were constant. This calibration update was provided to the processing system for archived Landsat data so that all future data products will be consistently calibrated and users will be able to better detect trends in the Earth's surface features.

Abstract

The Landsat-4 Thematic Mapper collected imagery of the Earth's surface from 1982 to 1993. Although largely overshadowed by Landsat 5, which was launched in 1984, Landsat 4 TM imagery extends the Thematic Mapper-based record of the Earth back to 1982 and also substantially supplements the image archive collected by Landsat 5. To provide a consistent calibration record for the TM instruments, Landsat 4 TM was cross-calibrated to Landsat 5 using nearly simultaneous overpass imagery of pseudo-invariant calibration sites (PICS) in the time period of 1988 through 1990. To determine if the radiometric gain of Landsat 4 had changed over its lifetime, time series from two PICS locations, a Saharan site known as Libya 4 and a site in southwest North America, commonly referred to as the Sonoran Desert PICS, were developed. Results indicated that Landsat 4 had been very stable over its lifetime with no discernible degradation in sensor performance in all the reflective bands except band 1. In contrast, band 1 exhibited a 12% decay in responsivity over the lifetime of the instrument. Results from this work have been implemented at USGS EROS, which enables users of Landsat TM data sets to obtain consistently calibrated data from Landsat 4 and 5 TM as well as Landsat 7 ETM+ instruments.