

SAFARI 2000 ALI/ETM+ Tandem Image Pair for Skukuza, South Africa, May 2001

Abstract

A tandem pair of Earth Observing 1 (EO-1) Advanced Land Imager (ALI) and Landsat-7 Enhanced Thematic Mapper Plus (ETM+) scenes covering the same part of South Africa's Kruger National Park (including the Skukuza tower site and rest camp) were acquired about a minute apart on May 30, 2001. The tandem pair was produced by NASA's GSFC Landsat-7 Project Science Office to evaluate the differences between the ALI and ETM+ and determine if technology similar to that of the ALI is suitable for collecting data comparable to that of the Landsat satellites.

The ALI is one of three instruments aboard NASA's first New Millennium Program (NMP) EO-1 satellite. ALI is a technology validation testbed that employs novel wide-angle optics and a highly integrated multispectral and panchromatic spectroradiometer. It was designed to produce images directly comparable to those of the ETM+ with substantial mass, volume, and cost savings. Ultimately, it is anticipated that ALI will demonstrate data continuity with previous Landsat images as well as advanced capability and innovative approaches to future land imaging that will continue the observations begun by the Landsat satellites in 1972.

The Skukuza ALI and ETM+ images use the 1.65 μm , 0.79 μm , and .565 μm wavelength bands, displayed as red, green, and blue, respectively. The similarity of the images from this exercise demonstrates the ability of the ALI to produce data comparable to ETM+ data. Several SAFARI 2000 field campaigns conducted in Kruger National Park provided ground-based data needed to evaluate measurements from each of the satellite sensors.

Background Information

Investigators:

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Project: SAFARI 2000
EOS Land Validation

Data Set Title: SAFARI 2000 ALI/ETM+ Tandem Image Pair for Skukuza, South Africa, May 2001

Site: SOUTHERN AFRICA

Westernmost Longitude: 31.4067671 E
Easternmost Longitude: 32.06807438 E
Northernmost Latitude: -24.076442837 S
Southernmost Latitude: -25.368809314 S

Projection Information:

Projection = UTM
UTM Zone = 36 South
Reference Ellipsoid = WGS84

Data Set Citation:

Irish, R. A. 2005. SAFARI 2000 ALI/ETM+ Tandem Image Pair for Skukuza, South Africa, May 2001. Data set. Available on-line [<http://daac.ornl.gov/>] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Product Description:

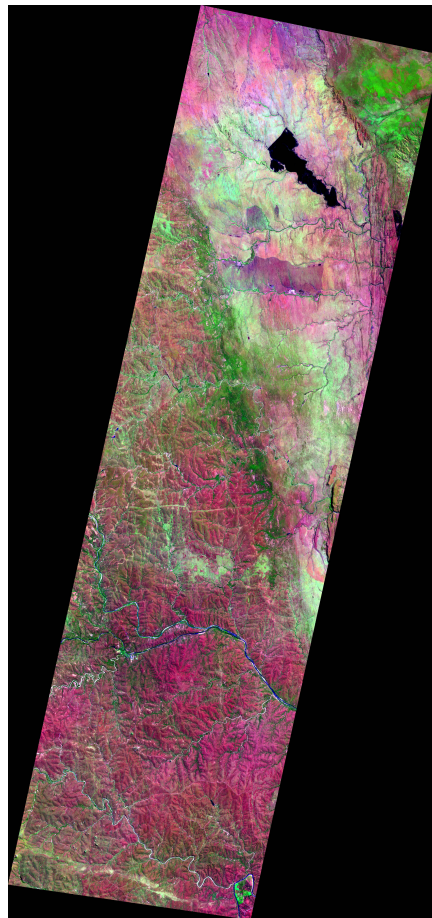
The tandem ALI and ETM+ image pair covers a portion of Kruger National Park in the Republic of South Africa. The park is on the border of South Africa and Mozambique and within its confines is Skukuza, the largest rest camp and also the operational, research, and administrative headquarters of the park. The park plays a key role in several NASA initiatives, including SAFARI 2000 and the EOS Land Validation Core Site network. It was also recently named an International Long Term Ecological Research (ILTER) site. Its vegetation is primarily woodlands, savanna and grassland.

The data sets consist of the common land area from a tandem pair acquired on May

30, 2001. All of the ALI and ETM+ bands listed in Table 2 (below) are included. The data are radiometrically and geometrically corrected. The geometric corrections applied are systematic (i.e. ground control points and terrain models were not employed).

The ALI and ETM+ images are false color composites combining shortwave infrared (1.65 μm), near infrared (.79 μm), and visible (.57 μm) wavelengths, displayed as red, green, and blue, respectively. Dense vegetation appears green. The similarity of the images demonstrates the ability of the ALI to produce data that can be compared with the 29-year archive of Landsat data. Several SAFARI 2000 field campaigns conducted in Kruger National Park provided ground-based data needed to evaluate measurements from each of the satellite sensors.

Sample Tandem Pair Images for Skukuza:



ALI image for Skukuza



ETM+ image for Skukuza

Data File Information:

Each band is stored as an individual binary file. There are no header records or embedded tags. The image files contain only image data. An ASCII metadata file accompanies each set of ALI and ETM+ band files and can be identified by the MTP designator in the file name. The metadata files document the path and row number, sample and line counts, band file names, and the sun azimuth and elevation angles. The Landsat-7 data set also includes the calibration parameter file that was used for 1R processing and can be identified by the L7CPF designator in the file name.

The ALI data values are stored as 16 bit (big endian) scaled radiances. To convert the scaled digital numbers (DN) to radiance units (watts/m²-ster-μm) the following equations should be used:

$$\text{ALI Radiance} = \text{DN} / 30$$

The ETM+ data values are stored as 8 bit scaled radiances. The following equation is used to convert DN's in a 1G product back to radiance units:

$$\text{Radiance} = \text{gain} * \text{DN} + \text{offset}$$

which is also expressed as:

$$\text{Radiance} = ((\text{LMAX}-\text{LMIN})/(\text{QCALMAX}-\text{QCALMIN})) * (\text{QCAL}-\text{QCALMIN}) + \text{LMIN}$$

where:

$$\text{QCALMIN} = 1$$

$$\text{QCALMAX} = 255$$

$$\text{QCAL} = \text{Digital Number}$$

The LMINs and LMAXs are the spectral radiances for each band at digital numbers 1 and 255 (i.e., QCALMIN, QCALMAX), respectively. They can be found in the ASCII calibration parameter file (file name: L7CPF20010401_20010630.02) included with this product.

Methods and Materials:

Data Collection:

The tandem pair of EO-1 ALI and Landsat-7 ETM+ scenes were acquired about a minute apart on May 30, 2001 over the same area of South Africa covering part of the Kruger National Park, including the Skukuza tower site and rest camp.

EO-1 flies about two minutes behind Landsat-7 along the exact same ground track.

Both the ALI and ETM+ sensors were designed to measure similar wavelengths at similar resolutions (see Tables 1 and 2 below). The ETM+ uses a spinning mirror to direct light into a single sensor for each wavelength of light it measures. On the other hand, the ALI uses a line of solid-state detectors (similar to a digital camera) that view the Earth's surface as the satellite orbits. The ALI is less expensive, smaller, and lighter than the ETM+, but the large number of detectors make it difficult to calibrate. To evaluate the differences between the ETM+ and ALI, and determine if technology similar to that of the ALI is suitable for collecting data comparable to that of the Landsat satellites, scientists are comparing matching scenes (e.g., Skukuza) from the two instruments.

Data Processing:

The calibration coefficients used for ALI correction are based on prelaunch measurements and do not yet take into account numerous solar, lunar and vicarious calibration measurements obtained since launch. Dead detectors were corrected but there was no attempt to correct for the small number of non-responsive detectors. Furthermore, an intermediate technique has been used to correct the three occurrences of the "Leaky Pixel" effect, a well characterized electronic cross-talk problem. Lastly, the overlapping pixels between SCAs have been eliminated by a simplistic partitioning process.

Spatial Coverage:

Kruger National Park, South Africa

Spatial Resolution:

30 meters

Temporal Coverage:

One day (May 30, 2001)

Other Relevant Information about the Study:

Field Sensor or Instrument Description:

The ALI is one of three instruments aboard NASA's first New Millennium Program (NMP) Earth Observing (EO-1) satellite. ALI is a technology validation testbed that employs novel wide-angle optics and a highly integrated multispectral and panchromatic spectroradiometer. It was designed to produce images directly comparable to those of the ETM+ with substantial mass, volume, and cost savings. Ultimately, it is anticipated that ALI will demonstrate data continuity with previous Landsat data as well as advanced capability and innovative approaches to future land imaging.

A summary of ALI and ETM+ instrument characteristics is provided in Table 1 below:

Parameters	ALI	ETM+
Spectral Range	0.4 - 2.4 μm	0.4 - 2.4 μm^*
Spatial Resolution	30 meters	30 meters
Swath Width	37 km	185 km
Spectral Resolution	Variable	Variable
Spectral Coverage	Discrete	Discrete
Pan Band Resolution	10 meters	15 meters
Number of Bands	10	7

* excluding the thermal band (10.4 - 12.5 μm)

ALI's multispectral/panchromatic array has 10 spectral bands in the visible/near infrared (VNIR) and short wave infrared (SWIR). The pan covers much of the visible portion of the VNIR spectrum and has a 10 m spatial resolution. The multispectral detectors have a 30 m resolution. Four sensor chip assemblies (SCA's)

make up the focal plane. For every multispectral band, each SCA contains 320 detectors in the cross-track direction, while the pan band contains 960 detectors.

The spectral bands for ALI as compared to ETM+ is provided in Table 2 below:

ALI/ETM+ Band Number	ALI Bandwidth (μm)	ETM+ Bandwidth (μm)
1'	0.433 - 0.453	-
1	0.45 - 0.515	0.45 - 0.52
2	0.525 - 0.605	0.53 - 0.61
3	0.63 - 0.69	0.63 - 0.69
4	0.775 - 0.805	0.78 - 0.90
4'	0.845 - 0.89	-
5'	1.20 - 1.30	-
5	1.55 - 1.75	1.55 - 1.75
7	2.08 - 2.35	2.09 - 2.33
Pan	0.48 - 0.69	0.52 - 0.90

Satellite Platform Web Sites:

NASA Earth Observing-1 (EO-1): <http://eo1.gsfc.nasa.gov/>

NASA Landsat 7: <http://landsat.gsfc.nasa.gov/>

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