LSDS-284
Version 9.0

Department of the Interior
U.S. Geological Survey

LANDSAT THEMATIC MAPPER (TM)
LEVEL 1 (L1)
DATA FORMAT CONTROL BOOK (DFCB)

Version 9.0

August 2016

LANDSAT THEMATIC MAPPER (TM)
LEVEL 1 (L1)
DATA FORMAT CONTROL BOOK (DFCB)

August 2016

Approved By:

_____

J. Lacasse Date
Landsat O&S CCB Chair
U.S. Geological Survey

EROS
Sioux Falls, South Dakota

Executive Summary

This Data Format Control Book (DFCB) presents detailed data formats of the output files that the Image Assessment System (IAS), Level 1 Product Generation System (LPGS), and National Land Archive Production System (NLAPS) generate. These Level 1 (L1) processing systems produce L1 output files from Level 0 Reformatted (L0R) images in the Geographic Tagged Image File Format (GeoTIFF).

The Landsat Operations and Sustaining (O&S) Configuration Control Board (CCB) maintains and controls this DFCB. Staff may update or revise this document only upon Landsat O&S CCB approval. Please direct comments and questions regarding this DFCB to the following:

Landsat Mission Management Officer
U.S. Geological Survey (USGS)
Earth Resources Observation and Science (EROS) Center
47914 252nd Street
Sioux Falls, SD 57198

Document History

Document Number	Document Version	Publication Date	Change Number
LS-DFCB-20	Version 1.0	December 2007	CCR 4622, CCR 4671, CCR 4708, CCR 4819, CCR 4821
LS-DFCB-20	Version 2.0	August 2008	CCR 4622, CCR 4671, CCR 4708, CCR 4819, CCR 4821
LS-DFCB-20	Version 3.0	January 2009	CCR 5598, CCR 5623
LS-DFCB-20	Version 4.0	August 2012	DCR 403, LCCR 439
LS-DFCB-20	Version 5.0	February 2013	DCR 1151, DCR 1156, CCR 6470
LSDS-284	Version 6.0	December 2013	CR 9653
LSDS-284	Version 7.0	May 2014	CR 11669
LSDS-284	Version 8.0	March 2015	CR 12100
LSDS-284	Version 9.0	August 2016	CR 12943

Contents

List of Tables

Section 1 Introduction

1.1 Purpose

This Data Format Control Book (DFCB) provides a high-level description of the Landsat Thematic Mapper (TM) Level 1 (L1) distribution product, output product packaging, and viewing tools.

1.2 Scope

This DFCB describes the formats and data contents of the L1 output files. The format discussed includes Geographic Tagged Image File Format (GeoTIFF).

The file formats contained in this DFCB are applicable to the product generated by L1 production systems operated at the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center.

1.3 Intended Users

This document is a guide for L1 product recipients. It provides detailed information on L1 product packaging.

1.4 Definitions

Level 0 Reformatted Archive (L0Ra) product — Raw Computer Compatible (RCC) data that have been reformatted to support data production and include individual band, browse data, a Mirror Scan Correction Data (MSCD) file, a Payload Correction Data (PCD) file, and Scene Metadata (MTL)

Level 0 Reformatted Product (L0Rp) digital image — Spatially reformatted, demultiplexed, and unrectified interval data

L0Rp product — L0Rp digital image plus radiometric, calibration, spacecraft attitude, and ephemeris data, consisting of the following files in Hierarchical Data Format (HDF):

- L0Rp digital image (one file per band)
- Internal Calibrator (IC) data — Calibration data file containing all of the calibration data received on a major frame basis subset to the product size ordered
- MSCD — Scan direction and error information subset to the product size ordered
- PCD — Information on spacecraft attitude and ephemeris, including quality indicators for the entire subinterval from which the product is derived
- Metadata — Descriptive information about the L0Rp image and names of appended files associated with the image
- Calibration Parameter File (CPF) — Formatted file containing radiometric and geometric correction parameters
- Scan Line Offsets (SLO) — Information on actual starting and ending pixel positions for valid image data on a line-by-line basis

- Geolocation table — File containing scene corner coordinates and product-specific scene line numbers for bands
- HDF directory — File containing all of the pointers, file size information, and data objects required to process the L0Rp product

Level 1 Radiometric (Corrected) (L1R) digital image — Radiometrically corrected but not geometrically resampled

Level 1 Geometrically (Corrected) (L1GS) digital image — Radiometrically corrected and resampled for geometric correction and registration to a geographic map projection

L1GS product — L1 product distributed by the Level 1 Product Generation System (LPGS) that includes, for all bands, GeoTIFF formatted L1GS images and associated data

Level 1 Terrain (Corrected) (L1TP) product — Includes radiometric, geometric, and precision correction, and uses a DEM to correct parallax error due to local topographic relief; the accuracy of the terrain-corrected product depends on the availability of Ground Control Points (GCPs), as well as the resolution of the best available DEM

Interval — Time duration between the start and stop of an imaging operation (observation) of the Landsat TM instrument

Worldwide Reference System (WRS) scene — Digital image that covers an area equivalent to one of the 57,784 scene centers (233 paths by 248 rows areas) defined by the WRS structure

1.5 Level 0 (L0) Pre-Archive Processing

A basic knowledge of the pre-archive ground processing enables the user to better understand the L1 product.

The Landsat Ground System (LGS) acquires TM wideband data directly from the Landsat TM spacecraft. The Landsat Archive Conversion System (LACS) records all wideband data, at real-time rates, into its wideband data stores. A single channel represents a complete data set and holds Bands 1 through 7. The LACS retrieves and processes raw wideband data, at lower than real-time rates, into separate accumulations of Earth image data, calibration data, MSCD, and PCD.

The LACS spatially reformats Earth imagery and calibration data into L0Ra data. This reformat involves shifting pixels by integer amounts to account for the alternating forward-reverse scanning pattern of the TM sensor, the odd-even detector arrangement within each band, and the detector offsets inherent to the focal plane array engineering design. All LACS Zero Reformatted (0R) data corrections are reversible; the Image Assessment System (IAS) CPF documents the pixel parameters used.

During LACS processing, bands are duplicated, aligned, and used to assess cloud cover content and to generate scene-based browse data. Cloud cover scores are generated on a scene-by-scene and quadrant-by-quadrant basis. Metadata are generated for the entire subinterval and on a scene-by-scene basis. The image data, PCD, MSCD, calibration data, and metadata are structured into HDF for each format and sent to EROS for archiving in subinterval form. The browse files are sent to EROS search and order systems separately for use as an online aid to ordering.

Section 2 Overview of L1 Output Files

This section provides an overview of the L1 output files.

2.1 L1GS / L1TP Output Files Overview

The L1GS digital image is radiometrically and geometrically corrected and is available in LPGS GeoTIFF and National Land Archive Production System (NLAPS) GeoTIFF format. The L1TP product includes radiometric, geometric, and precision correction, and uses a DEM to correct parallax error due to local topographic relief.

The on-demand L1 products available for download at no charge are generated using a standard set of parameters. These are the only processing parameters available for the L1 output products through the external ordering interface(s). These products are output using the best available processing level for that particular scene (L1TP or L1GS). The processing parameters and output product details used for all standard products are as follows:

- Pixel Size — 30 meter (m)
- Output Format — GeoTIFF
- Resampling Method — Cubic Convolution (CC)
- Map Projection — Universal Transverse Mercator (UTM)
  Polar Stereographic (PS) for Antarctica scenes
- Datum — World Geodetic System 1984 (WGS84)
- Image Orientation — Map (North Up (NUP))
- Distribution — Hypertext Transfer Protocol (HTTP) Download

Quality Band (QB) file	X	X
Angle Coefficient File	X	X

Table 2-1 and Table 2-2 detail the L1 product components included with each format. The number of bands and optional data files that the user orders determines the number of components included with a specific product.

Component	L1GS	L1TP
L1 image file (for each requested band)	X	X
L1 Metadata file (text [.txt] file)	X	X
GCP file (text [.txt] file)		X
Three Band Verification Browse Image (JPEG [.JPG] file)		X
Geometric Verification Statistics file (text [.txt] file)		X
Quality Band (QB) file	X	X
Angle Coefficient File	X	X

Table 2-1. LPGS GeoTIFF Product Components

Component	L1GS	L1TP
L1 image file (for each requested band)	X	X
Work order report file	X	X

Table 2-2. NLAPS GeoTiff Product Components

2.2 Naming Convention

The file-naming convention for the LPGS GeoTIFF product is as follows:

<LANDSAT_PRODUCT_ID>_BN.XXX, where LANDSAT_PRODUCT_ID is LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_QQ, where:

L	=	Landsat
X	=	Sensor T = TM
SS	=	Satellite 04 = Landsat 4 05 = Landsat 5
LLL	=	Processing Level (L1TP, L1GS)
PPP	=	Three-digit WRS path
RRR	=	Three-digit WRS row
YYYYMMDD	=	Acquisition Year (YYYY) / Month (MM) / Day (DD)
yyyymmdd	=	Processing Year (yyyy) / Month (mm) / Day (dd)
CC	=	Collection Number
QQ	=	Collection Category: RT = Real-Time T1 = Tier 1 (stackable) T2 = Tier 2 (non-stackable)
BN	=	Product Component: B1 = Band 1 B2 = Band 2 B3 = Band 3 B4 = Band 4 B5 = Band 5 B6 = Band 6 B7 = Band 7 BQA = Quality Band GCP = GCP File VER = Verification File MTL = Metadata File ANG = Angle Coefficient File
XXX	=	File type: = TIF file extension for all image data = JPG file extension for the verification browse = .txt file extension for GCP, VER, and L1 Metadata (MTL) files

Table 2-3. LPGS GeoTIFF Product Naming Convention

The file-naming convention for the NLAPS GeoTIFF product files is as follows:

LLNpppprrrOOYYDDDMM_AA.XXX, where:

LL	=	L = Landsat sensor (LT for TM data)
N	=	Satellite number 4 = Landsat 4 5 = Landsat 5
ppp	=	Starting path of the product
rrr	=	Starting row of the product
OO	=	WRS row offset (set to 00)
YY	=	Last two digits of the acquisition year
DDD	=	Julian date of acquisition
MM	=	Instrument mode: 50 = TM
AA	=	File Type B1 = Band 1 B2 = Band 2 B3 = Band 3 B4 = Band 4 B5 = Band 5 B6 = Band 6 B7 = Band 7 WO = Processing history file
XXX	=	File Extension: .tif = GeoTIFF file .txt = American Standard Code for Information Interchange (ASCII) text file

Table 2-4. NLAPS GeoTIFF Naming Convention

Section 3 L1 Output File Formats

This section describes the storage format for the data.

3.1 LPGS GeoTIFF File Formats

GeoTIFF defines a set of public domain Tagged Image File Format (TIFF) tags that describe all cartographic and geodetic information associated with GeoTIFF imagery. GeoTIFF is a means for tying a raster image to a known model space or map projection and for describing those projections. An MTL format provides geographic information to associate with the image data, but the TIFF file structure allows both the metadata and the image data to be encoded into the same file.

3.1.1 L1 Image File

The description of an image in GeoTIFF requires tags and keys as described in the GeoTIFF Specification document (see References). The L1 image files include these tags and keys, which TIFF readers automatically detect and read. The following sections describe the tags and keys.

Each Earth image band in the requested product is contained in a separate file. These data are laid out in a scan line sequential format in descending detector order (e.g., detector 16 followed by detector 15 and so forth for the 30 m bands). The L1R image is radiometrically corrected but not geometrically resampled. The L1S image is radiometrically corrected and resampled for geometric correction and registration to geographic map projections. The L1TP image is radiometrically, geometrically, and precision corrected, and uses a DEM to correct parallax error due to local topographic relief.

3.1.1.1 GeoTIFF Tags

TIFF tags convey metadata information about the image. The tags describe the image with information that the TIFF reader needs to control the appearance of the image on the user's screen. The TIFF tags are in the same file as the TIFF image.

A complete description of the raster data requires georeferencing of the data, which uses tags. Landsat TM L1 production systems use the transformation raster, model space tie points, and scaling parameters. ModelTiepointTag and ModelPixelScaleTag are used for this purpose.

ModelTiepointTag
Tag = 33922
Type = DOUBLE
N = 6*K, K = number of tiepoints
Alias: GeoreferenceTag
Owner: Intergraph

This tag stores the raster-to-model tiepoint pairs in the following order:

ModelTiepointTag = (..., I, J, K, X, Y, Z...),

where (I, J, K) is the point at location (I, J) in raster space with pixel-value K, and (X, Y, Z) is a vector in model space.

The raster image is georeferenced by specifying its location, size, and orientation in the model coordinate space. Because the relationship between the raster space and the model space is often an exact, affine transformation, the relationship can be defined using one set of tiepoints and the ModelPixelScaleTag, which gives the vertical and horizontal raster grid cell size.

ModelPixelScaleTag
Tag = 33550
Type = DOUBLE
N = 3
Owner: SoftDesk

This tag specifies the size of raster pixel spacing in the model space units when the raster space can be embedded in the model space coordinate system without rotation, and consists of the following three values:

ModelPixelScaleTag = (ScaleX, ScaleY, ScaleZ)

where ScaleX and ScaleY give the horizontal and vertical spacing of raster pixels, and ScaleZ maps the pixel value of a DEM into the correct Z-scale. ScaleZ is not used for L1S data because it is only systematically corrected and not corrected for elevation.

A single tiepoint in the ModelTiepointTag, together with the ModelPixelScaleTag, completely determines the relationship between raster and model space.

3.1.1.2 GeoTIFF Keys

In addition to tags, the description of a projection in GeoTIFF requires using keys. Table 3-1 lists the keys necessary to define the projections supported by the L1 production systems and the possible values of the keys.

Valid Keys	Possible Values	Meaning
Universal Transverse Mercator (UTM)		
GTModelTypeGeoKey	1	ModelTypeProjected (Projection Coordinate System)
GTRasterTypeGeoKey	1	RasterPixelIsArea
	2	RasterPixelIsPoint
GTCitationGeoKey	(ASCII, 17)	ASCII reference to public documentation
GeogLinearUnitsGeoKey	9001	Linear_Meter
	9002	Linear_Foot
GeogAngularUnitsGeoKey	9102	Angular_Degree
ProjectedCSTypeGeoKey	20000 - 32760	European Petroleum Survey Group (EPSG) Projection System Codes
	32767	User-defined
Polar Stereographic (PS)		
ProjCoordTransGeoKey	15	CT_PolarStereographic
GTModelTypeGeoKey	1	ModelTypeProjected (Projection Coordinate System)
GTRasterTypeGeoKey	1	RasterPixelIsArea
	2	RasterPixelIsPoint
GTCitationGeoKey	(ASCII, 17)	ASCII reference to public documentation
GeographicTypeGeoKey	4326	GCS_WGS_84
GeogLinearUnitsGeoKey	9001	Linear_Meter
	9002	Linear_Foot
GeogAngularUnitsGeoKey	9102	Angular_Degree
ProjectedCSTypeGeoKey	20000 - 32760	EPSG Projection System Codes
	32767	User-defined
ProjectionGeoKey	10000 - 19999	EPSG / Petrotechnical Open Software Corporation (POSC) Projection Codes
	32767	User-defined
ProjLinearUnitsGeoKey	9001	Linear_Meter
	9002	Linear_Foot
ProjStraightVertPoleLongGeoKey		Value in units of GeogAngularUnits
ProjNatOriginLatGeoKey		Value in units of GeogAngularUnits
ProjFalseNorthingGeoKey		Value entered in units of ProjLinearUnits
ProjFalseEastingGeoKey		Value entered in units of ProjLinearUnits

Table 3-1. GeoTIFF Keys

3.1.2 Quality Band (QB) File

The QB file contains quality statistics gathered from the image data and cloud mask information for the scene. The QB file is an unsigned 16-bit image with the same dimensions as the L1 scene. Bit 0 is the least significant. Bits are allocated for data artifacts and several land surface classification types. A range of confidence levels are provided for each classification type.

The bit confidence levels are as follows:

00 No confidence level set (used for fill or for a class not reported)
01 Low confidence
10 Mid confidence
11 High confidence

Bit	Flag Description	Values
0	Designated Fill	0 or 1 Not checked
1	Dropped Pixel	0 Not likely to exist 1 Likely to exist
2-3	Radiometric Saturation	00 No bands saturated 01 1 to 2 bands saturated 10 3 to 4 bands saturated 11 Greater than 4 bands saturated
4	Cloud	0 Not likely to exist 1 Likely to exist
5-6	Cloud Confidence	00 Not checked 01 Low confidence 10 Mid confidence 11 High confidence
7-8	Cloud Shadow	00 Not checked 01 Low confidence 10 Mid confidence 11 High confidence
9-10	Snow/Ice	00 Not checked 01 Low confidence 10 Mid confidence 11 High confidence
11-15		Unused

Table 3-2. QBBit Description

3.1.3 L1 Metadata File

The L1 MTL file is created during product generation and contains information specific to the product ordered. Table 3-3 lists the full contents of the L1 MTL file. This file contains all applicable image description information from the L0Rp Metadata file and the Landsat Processing System (LPS) metadata provided with the L0Rp product. The MTL file complies with LSDS-524 Landsat Metadata Description Document (LMDD) (see References).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
GROUP	18	= L1_METADATA_FILE	Beginning of the first-level Object Description Language (ODL) group; it indicates the start of the L1 MTL file level group.
GROUP	18	= METADATA_FILE_INFO	Beginning of the Metadata file information group.
ORIGIN	47	= “Image courtesy of the U.S. Geological Survey”	Establishes the origin of the image from the USGS.
REQUEST_ID	20	USGS products use: “NNNYYMMDDSSSS_UUUUU” format Where: NNNYYMMDDSSSS = 13-digit Tracking, Routing, and Metrics (TRAM) order number NNN = Node indicator YY = Year MM = Month DD = Day SSSS = Sequence number for the day UUUUU = Five-digit TRAM unit number	Data producer-defined request number that uniquely identifies each product. USGS products use a unique product generation TRAM-generated request ID.
LANDSAT_SCENE_ID	21	= “LMSPPPRRRYYYYDDDGSIVV” Where: L = Landsat M = Mission (T = TM)) S = Satellite (4 or 5) PPP = WRS path RRR = WRS row YYYY = Year of acquisition DDD = Day of acquisition year GSI = Ground Station Identifier VV = Version	Unique Landsat scene identifier. (Earth-imaging), orbital Path/Row.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
LANDSAT_PRODUCT_ID	40	= "LXSS_LLLL_PPPRRR_YYYYDDMM_yyyymmdd_CC_QQ" Where: L = Landsat X = Sensor SS = Satellite LLLL = Processing level PPP = WRS path RRR = WRS row YYYYDDMM = Acquisition year / month / day yyyymmdd = Processing year / month / day CC = Collection number QQ = Collection category	Unique Landsat product identifier. (Earth-imaging), orbital Path/Row.
COLLECTION_NUMBER	2	= 0 to 99	Unique two digit identifier to denote the collection number.
FILE_DATE	20	= YYYY-MM-DDTHH:MI:SSZ Where: YYYY = Four-digit Julian year MM = Month number of the Julian year (01-12) DD = Day of the Julian month (01-31)F T = Start of time information in ODL ASCII time code format HH = Hours (00-23) MI = Minutes (00-59) SS = Seconds (00-59) Z = Zulu time (same as Greenwich Mean Time (GMT))	L1 system date and time when the Metadata file for the L1 product set was created.
STATION_ID	3	= "NNN"	Ground Station that received the data.
PROCESSING_SOFTWARE_VERSION	20	= "SYSTEM_VERSION" Where: SYSTEM = LPGS, IAS VERSION = Version of software	Software name followed by version number(s) and separated by underscores. Example: LPGS_8.2.3

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
DATA_CATEGORY	11	= “NOMINAL” = “VALIDATION” = “EXCHANGE” = “TEST” = “ENGINEERING”	Current data category assigned to the data. Values: NOMINAL = Nominal data that exists within expected, acceptable limits. VALIDATION = Validation data obtained from an International Ground Station (IGS) in order to validate that the IGS data are of equivalent quality to those that the USGS maintains. EXCHANGE = Exchange data (between an IGS and the USGS) that require a quarantine period and have been successfully validated to be of equivalent quality to the corresponding USGS data. TEST = Test data. ENGINEERING = Engineering data that typically results from an inclination change to the spacecraft or Delta I Maneuver. Refer to LSDS-293 Landsat Data Management Policy.
END_GROUP	18	= METADATA_FILE_INFO	End of the MTL information group.
GROUP	16	= PRODUCT_METADATA	Beginning of the product metadata group.
DATA_TYPE	20	= “L1GS“ = “ “ = “L1TP“	Identifier to inform the user of the data type.
DATA_TYPE_L0RP	20	= “TMA_L0RP” = “TMR_L0RP”	Data type identifier string used to create the L0Rp product.
ELEVATION_SOURCE	7	= “NED” = “SRTM1” = “SRTM3” = “GTOPO30” = “GLS2000”	Identifies the digital elevation data set used to terrain correct the product.
OUTPUT_FORMAT	10	= “GEOTIFF”	The output format.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
EPHEMERIS_TYPE	10	= “DEFINITIVE” = “PREDICTIVE”	Identifier to inform the user of the orbital ephemeris type used. If the field is not present, the user should assume PREDICTIVE in all cases (geometrically-corrected product only).
SPACECRAFT_ID	8	= “LANDSAT_4” = “LANDSAT_5”	Name of the satellite platform.
SENSOR_ID	4	= “TM”	Name of the imaging sensor.
SENSOR_MODE	6	= “SAM” = “BUMPER”	Scan Angle Monitor (SAM) Mode and Bumper (BUMPER) Mode.
WRS_PATH	3	= NNN, where NNN = the path number (001-251)	WRS-defined nominal Landsat satellite track (path). (orbital)
WRS_ROW	3	= NNN, where NNN = the row of the first full or partial scene in the product (001-248)	WRS-defined nominal Landsat satellite row, based on the latitudinal center frame of a Landsat image. (orbital)
DATE_ACQUIRED	10	= YYYY-MM-DD	Date that this scene was imaged.
SCENE_CENTER_TIME	14	= “HH:MI:SS.SSSSSSSZ” Where: HH = Hour (00-23) MI = Minutes SS.SSSSSSS = Fractional seconds Z = Constant (indicates "Zulu" time (same as GMT))	Scene center time of the date the image was acquired.
CORNER_UL_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees. Positive (+) value indicates north latitude; negative (-) value indicates south latitude.	Latitude value for the upper-left corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_UL_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees. Positive (+) value indicates east longitude; negative (-) value indicates west longitude.	Longitude value for the upper-left corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_UR_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees.	Latitude value for the upper-right corner of the product (the L1 systems recalculate for the geometrically-corrected product).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
CORNER_UR_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees.	Longitude value for the upper-right corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_LL_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees.	Latitude value for the lower-left corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_LL_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees.	Longitude value for the lower-left corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_LR_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees.	Latitude value for the lower-right corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_LR_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees.	Longitude value for the lower-right corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_UL_PROJECTION_X_PRODUCT	14	= -132000000.000 - 132000000.000 Units are feet or meters	Projection X coordinate for the upper-left corner of the product (the L1 systems calculated, geometrically-corrected only).
CORNER_UL_PROJECTION_Y_PRODUCT	14	= -132000000.000 - 132000000.000 Units are feet or meters	Projection Y coordinate for the upper-left corner of the product (L1 systems calculated, geometrically-corrected only).
CORNER_UR_PROJECTION_X_PRODUCT	14	= -132000000.000 - 132000000.000 Units are feet or meters	Projection X coordinate for the upper-right corner of the product (L1 systems calculated, geometrically-corrected only).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
CORNER_UR_PROJECTION_Y_PRODUCT	14	= -132000000.000 - 132000000.000 Units are feet or meters	Projection Y coordinate for the upper-right corner of the product (L1 systems calculated, geometrically-corrected only).
CORNER_LL_PROJECTION_X_PRODUCT	14	= -132000000.000 - 132000000.000 Units are feet or meters	Projection X coordinate for the lower-left corner of the product (L1 systems calculated, 1G only).
CORNER_LL_PROJECTION_Y_PRODUCT	14	= -132000000.000 - 132000000.000 Units are feet or meters	Projection Y coordinate for the lower-left corner of the product (L1 systems calculated, geometrically-corrected only).
CORNER_LR_PROJECTION_X_PRODUCT	14	= -132000000.000 - 132000000.000 Units are feet or meters	Projection X coordinate for the lower-right corner of the product (L1 systems calculated, geometrically-corrected only).
CORNER_LR_PROJECTION_Y_PRODUCT	14	= -132000000.000 - 132000000.000 Units are feet or meters	Projection Y coordinate for the lower-right corner of the product (L1 systems calculated, geometrically-corrected only).
REFLECTIVE_LINES	5	= NNNNN	Number of product lines for the reflective bands.
REFLECTIVE_SAMPLES	5	= NNNNN	Number of product samples for the reflective bands.
THERMAL_LINES	5	= NNNNN	Product lines for the thermal band.
THERMAL_SAMPLES	5	= NNNNN	Product samples for the thermal band.
FILE_NAME_BAND_1	256	“<LANDSAT_PRODUCT_ID>_B1.TIF”	L1-generated external element file name for Band 1.
FILE_NAME_BAND_2	256	“<LANDSAT_PRODUCT_ID>_B2.TIF”	L1-generated external element file name for Band 2.
FILE_NAME_BAND_3	256	“<LANDSAT_PRODUCT_ID>_B3.TIF”	L1-generated external element file name for Band 3.
FILE_NAME_BAND_4	256	“<LANDSAT_PRODUCT_ID>_B4.TIF”	L1-generated external element file name for Band 4.
FILE_NAME_BAND_5	256	“<LANDSAT_PRODUCT_ID>_B5.TIF”	L1-generated external element file name for Band 5.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
FILE_NAME_BAND_6	256	“<LANDSAT_PRODUCT_ID>_B6.TIF”	L1-generated external element file name for Band 6.
FILE_NAME_BAND_7	256	“<LANDSAT_PRODUCT_ID>_B7.TIF”	L1-generated external element file name for Band 7.
FILE_NAME_BAND_QUALITY	256	“<LANDSAT_PRODUCT_ID>_BQA.TIF”	L1-generated external element file name for the QB, if part of the product.
GROUND_CONTROL_POINT_FILE_NAME	256	“<LANDSAT_PRODUCT_ID>_GCP.txt”	L1-generated external element file name for the GCP, if part of the product.
REPORT_VERIFY_FILE_NAME	256	“<LANDSAT_PRODUCT_ID>_VER.txt”	L1-generated external element file name where information from the scoring of geometric verification is located.
BROWSE_VERIFY_FILE_NAME	256	“<LANDSAT_PRODUCT_ID>_VER.jpg”	L1-generated external element file name for the Three Band Browse file (JPEG file), if part of the product.
ANGLE_COEFFICIENT_FILE_NAME	256	“<LANDSAT_PRODUCT_ID>_ANG.txt”	Name of the angle coefficient file.
METADATA_FILE_NAME	256	"<LANDSAT_PRODUCT_ID>_MTL.txt”	Name of the Metadata file.
CPF_NAME	256	LXSSCPF_YYYYMMDD_yyyymmdd_CC.NN Where: L = Landsat X= Instrument SS= Satellite (05 for Landsat 5) CPF= 3 letter CPF designator YYYYMMDD = Effective Starting Date yyyymmdd = Effective Ending Date CC= Collection Number (e.g.02) NN= Version Number for this file (Starts with 00)	Archive-generated external element file name for the IAS CPF.
END_GROUP	16	= PRODUCT_METADATA	End of the product metadata group.
GROUP	17	= IMAGE_ATTRIBUTES	Beginning of the image attributes group.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
CLOUD_COVER	5	0.00-100.00, -1	Cloud coverage (percent) assigned to a WRS scene. Values: -1 = Cloud cover not calculated or assessed.
CLOUD_COVER_LAND	5	= 0.00-100.00, -1	Cloud coverage over land (percent) assigned to a WRS scene. Values: -1 = Cloud cover land not calculated or assessed.
IMAGE_QUALITY	1	0-9, -1	Composite image quality for the bands. Values: 9 = Best. 0 = Worst. -1 = Image quality not calculated or assessed.
SUN_AZIMUTH	11	= -180.00000000 - 180.00000000 degrees. A positive value indicates angles to the east or clockwise from the north. A negative value (-) indicates angles to the west or counterclockwise from the north. Leading zeros are not required.	Sun azimuth angle in degrees for the image center location at the image center acquisition time.
SUN_ELEVATION	10	= -90.00000000 - 90.00000000 degrees. A positive value indicates a daytime scene. A negative value (-) indicates a nighttime scene. Leading zeros are not required.	Sun elevation angle in degrees for the image center location at the image center acquisition time.
EARTH_SUN_DISTANCE		= N.NNNNNNN	Measurement (astronomical unit) of the earth to sun distance at the particular day and time of imagery acquisition.
GROUND_CONTROL_POINTS_VERSION	3	= 0 - 999	GCP version used for processing.
GROUND_CONTROL_POINTS_MODEL	3	= 1 - 999	Number of GCPs used in the precision correction process.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
GEOMETRIC_RMSE_MODEL	7	= 0.000 – 9999.999	Combined Root Mean Square Error (RMSE) of the geometric residuals (meters) in both across-track and along-track directions measured on the GCPs used in geometric precision correction.
GEOMETRIC_RMSE_MODEL_Y	7	= 0.000 – 9999.999	RMSE of the geometric residuals (meters) measured on the GCPs used in geometric precision correction.
GEOMETRIC_RMSE_MODEL_X	7	= 0.000 – 9999.999	RMSE of the geometric residuals (meters) measured on the GCPs used in geometric precision correction.
GROUND_CONTROL_POINTS_VERIFY	4	= 1 - 9999	Number of GCPs used in the verification of the terrain-corrected product.
GEOMETRIC_RMSE_VERIFY	7	= 0.000 – 9999.999	RMSE of the geometric residuals (pixels) in both line and sample directions measured on the terrain-corrected product independently using GLS2000.
GEOMETRIC_RMSE_VERIFY_QUAD_UL	7	= 0.000 – 9999.999	RMSE of the geometric residuals (pixels) for the upper-left quadrant in both line and sample directions measured on the terrain-corrected product independently using GLS2000.
GEOMETRIC_RMSE_VERIFY_QUAD_UR	7	= 0.000 – 9999.999	RMSE of the geometric residuals (pixels) for the upper-right quadrant in both line and sample directions measured on the terrain-corrected product independently using GLS2000.
GEOMETRIC_RMSE_VERIFY_QUAD_LL	7	= 0.000 – 9999.999	RMSE of the geometric residuals (pixels) for the lower-left quadrant in both line and sample directions measured on the terrain-corrected product independently using GLS2000.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
GEOMETRIC_RMSE_VERIFY_QUAD_LR	7	= 0.000 – 9999.999	RMSE of the geometric residuals (pixels) for the lower-right quadrant in both line and sample directions measured on the terrain-corrected product independently using GLS2000.
SATURATION_BAND_1	1	= “Y” (Yes) = “N” (No) = “U” (Unknown)	“Yes” indicates the band contains saturation; ”No” indicates the band does not contain any saturation.
SATURATION_BAND_2	1	= “Y” (Yes) = “N” (No) = “U” (Unknown)	”Yes” indicates the band contains saturation; “No” indicates the band does not contain any saturation.
SATURATION_BAND_3	1	= “Y” (Yes) = “N” (No) = “U” (Unknown)	”Yes” indicates the band contains saturation; ”No” indicates the band does not contain any saturation.
SATURATION_BAND_4	1	= “Y” (Yes) = “N” (No) = “U” (Unknown)	”Yes” indicates the band contains saturation; ”No” indicates the band does not contain any saturation.
SATURATION_BAND_5	1	= “Y” (Yes) = “N” (No) = “U” (Unknown)	”Yes” indicates the band contains saturation; ”No” indicates the band does not contain any saturation.
SATURATION_BAND_6	1	= “Y” (Yes) = “N” (No) = “U” (Unknown)	”Yes” indicates the band contains saturation; ”No” indicates the band does not contain any saturation.
SATURATION_BAND_7	1	= “Y” (Yes) = “N” (No) = “U” (Unknown)	”Yes” indicates the band contains saturation; “No” indicates the band does not contain any saturation.
END_GROUP	17	= IMAGE_ATTRIBUTES	End of the image attributes group.
GROUP	16	= MIN_MAX_RADIANCE	Beginning of the minimum / maximum radiance group (geometrically-corrected product only).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
RADIANCE_MAXIMUM_BAND_1	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 1, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_1.
RADIANCE_MINIMUM_BAND_1	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 1, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_1.
RADIANCE_MAXIMUM_BAND_2	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 2, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_2.
RADIANCE_MINIMUM_BAND_2	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 2, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_2.
RADIANCE_MAXIMUM_BAND_3	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 3, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_3.
RADIANCE_MINIMUM_BAND_3	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 3, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_3.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
RADIANCE_MAXIMUM_BAND_4	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 4, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_4.
RADIANCE_MINIMUM_BAND_4	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 4, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_4.
RADIANCE_MAXIMUM_BAND_5	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 5, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_5.
RADIANCE_MINIMUM_BAND_5	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 5, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_5.
RADIANCE_MAXIMUM_BAND_6	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 6, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_6.
RADIANCE_MINIMUM_BAND_6	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 6, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_6.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
RADIANCE_MAXIMUM_BAND_7	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 7, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_7.
RADIANCE_MINIMUM_BAND_7	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 7, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_7.
END_GROUP	16	= MIN_MAX_RADIANCE	End of the minimum / maximum radiance group.
GROUP	16	= MIN_MAX_REFLECTANCE	Beginning of the minimum / maximum reflectance group.
REFLECTANCE_MAXIMUM_BAND_1	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 1.
REFLECTANCE_MINIMUM_BAND_1	9	= -1.000000-1.000000	Minimum achievable reflectance value for Band 1.
REFLECTANCE_MAXIMUM_BAND_2	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 2.
REFLECTANCE_MINIMUM_BAND_2	9	= -1.000000-1.000000	Minimum achievable reflectance value for Band 2.
REFLECTANCE_MAXIMUM_BAND_3	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 3.
REFLECTANCE_MINIMUM_BAND_3	9	= -1.000000-1.000000	Minimum achievable reflectance value for Band 3.
REFLECTANCE_MAXIMUM_BAND_4	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 4.
REFLECTANCE_MINIMUM_BAND_4	9	= -1.000000-1.000000	Minimum achievable reflectance value for Band 4.
REFLECTANCE_MAXIMUM_BAND_5	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 5.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
REFLECTANCE_MINIMUM_BAND_5	9	= -1.000000-1.000000	Minimum achievable reflectance value for Band 5.
REFLECTANCE_MAXIMUM_BAND_7	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 7.
REFLECTANCE_MINIMUM_BAND_7	9	= -1.000000-1.000000	Minimum achievable reflectance value for Band 7.
END_GROUP	16	= MIN_MAX_REFLECTANCE	End of the minimum / maximum reflectance group.
GROUP	19	= MIN_MAX_PIXEL_VALUE	Beginning of the minimum / maximum pixel value group (geometrically-corrected product only).
QUANTIZE_CAL_MAX_BAND_1	3	= 0 – 255	Maximum possible pixel value for Band 1, if part of the product (Digital Number (DN)).
QUANTIZE_CAL_MIN_BAND_1	1	= 0 – 1	Minimum possible pixel value for Band 1, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_2	3	= 0 – 255	Maximum possible pixel value for Band 2, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_2	1	= 0 – 1	Minimum possible pixel value for Band 2, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_3	3	= 0 – 255	Maximum possible pixel value for Band 3, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_3	1	= 0 – 1	Minimum possible pixel value for Band 3, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_4	3	= 0 – 255	Maximum possible pixel value for Band 4, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_4	1	= 0 – 1	Minimum possible pixel value for Band 4, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_5	3	= 0 – 255	Maximum possible pixel value for Band 5, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_5	1	= 0 – 1	Minimum possible pixel value for Band 5, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_6	3	= 0 – 255	Maximum possible pixel value for Band 6, if part of the product (DN).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
QUANTIZE_CAL_MIN_BAND_6	1	= 0 – 1	Minimum possible pixel value for Band 6, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_7	3	= 0 – 255	Maximum possible pixel value for Band 7, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_7	1	= 0 – 1	Minimum possible pixel value for Band 7, if part of the product (DN).
END_GROUP	19	= MIN_MAX_PIXEL_VALUE	End of the minimum / maximum pixel value group.
GROUP	18	= PRODUCT_PARAMETERS	Beginning of the product parameters group (both 1R and geometrically-corrected products).
CORRECTION_GAIN_BAND_1	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Gain correction method used by L1 in creating the image for Band 1, if part of the product.
CORRECTION_GAIN_BAND_2	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Gain correction method used by L1 in creating the image for Band 2, if part of the product.
CORRECTION_GAIN_BAND_3	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Gain correction method used by L1 in creating the image for Band 3, if part of the product.
CORRECTION_GAIN_BAND_4	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Gain correction method used by L1 in creating the image for Band 4, if part of the product.
CORRECTION_GAIN_BAND_5	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Gain correction method used by L1 in creating the image for Band 5, if part of the product
CORRECTION_GAIN_BAND_6	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Gain correction method used by L1 in creating the image for Band 6, if part of the product.
CORRECTION_GAIN_BAND_7	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Gain correction method used by L1 in creating the image for Band 7, if part of the product.
CORRECTION_BIAS_BAND_1	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 1, if part of the product.
CORRECTION_BIAS_BAND_2	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 2, if part of the product.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
CORRECTION_BIAS_BAND_3	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 3, if part of the product
CORRECTION_BIAS_BAND_4	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 4, if part of the product.
CORRECTION_BIAS_BAND_5	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 5, if part of the product.
CORRECTION_BIAS_BAND_6	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 6, if part of the product.
CORRECTION_BIAS_BAND_7	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 7, if part of the product.
END_GROUP	18	= PRODUCT_PARAMETERS	End of the product parameters group.
GROUP	21	= RADIOMETRIC_RESCALING	Beginning of the radiometric rescaling parameters group.
RADIANCE_MULT_BAND_1	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 1 (w/(m^2 sr micron) / DN).
RADIANCE_MULT_BAND_2	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 2 (w/(m^2 sr micron) / DN
RADIANCE_MULT_BAND_3	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 3 (w/(m^2 sr micron) / DN).
RADIANCE_MULT_BAND_4	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 4 (w/(m^2 sr micron) / DN).
RADIANCE_MULT_BAND_5	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
			5 (w/(m^2 sr micron) / DN).
RADIANCE_MULT_BAND_6	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 6 (w/(m^2 sr micron) / DN).
RADIANCE_MULT_BAND_7	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 7 (w/(m^2 sr micron) / DN).
RADIANCE_ADD_BAND_1	7	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 1.
RADIANCE_ADD_BAND_2	7	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 2.
RADIANCE_ADD_BAND_3	7	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 3.
RADIANCE_ADD_BAND_4	7	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 4.
RADIANCE_ADD_BAND_5	7	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 5.
RADIANCE_ADD_BAND_6	7	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 6.
RADIANCE_ADD_BAND_7	7	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 7.
REFLECTANCE_MULT_BAND_1	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
			to reflectance for Band 1 (DN^{-1}).
REFLECTANCE_MULT_BAND_2	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 2 (DN^{-1}).
REFLECTANCE_MULT_BAND_3	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 3 (DN^{-1}).
REFLECTANCE_MULT_BAND_4	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 4 (DN^{-1}).
REFLECTANCE_MULT_BAND_5	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 5 (DN^{-1}).
REFLECTANCE_MULT_BAND_7	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 7 (DN^{-1}).
REFLECTANCE_ADD_BAND_1	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 1.
REFLECTANCE_ADD_BAND_2	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 2.
REFLECTANCE_ADD_BAND_3	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 3.
REFLECTANCE_ADD_BAND_4	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 4.
REFLECTANCE_ADD_BAND_5	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 5.
REFLECTANCE_ADD_BAND_7	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 7.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
END_GROUP	21	= RADIOMETRIC_RESCALING	End of the radiometric rescaling parameters group.
GROUP		= THERMAL_CONSTANTS	Beginning of thermal constants group.
K1_CONSTANT_BAND_6	7	NNNN.NN	Calibration constant for Band 6 radiance to temperature conversion.
K2_CONSTANT_BAND_6	7	NNNN.NN	Calibration constant for Band 6 radiance to temperature conversion.
END_GROUP	17	= THERMAL_CONSTANTS	End of thermal constants group.
GROUP	21	= PROJECTION_PARAMETERS	Beginning of the projection parameters group (geometrically-corrected product only).
MAP_PROJECTION	4	= “PS” (Polar Stereographic) = ”UTM” (Universal Transverse Mercator)	Map projection used in creating the image.
DATUM	5	= “WGS84”	Datum used in creating the image.
ELLIPSOID	5	= “WGS84”	Ellipsoid used in creating the image.
UTM_ZONE	2	= 1-60	UTM zone number in a map projection. A negative zone indicates that the false northing needs to be applied to the northing coordinate and a positive zone indicates that the false northing has been applied. Only present when MAP_PROJECTION is UTM.
VERTICAL_LON_FROM_POLE	8	= -180.00000 through +180.00000	Vertical longitude (decimal degrees) from the pole. Only present when MAP_PROJECTION is PS.
TRUE_SCALE_LAT	7	= -90.00000 through +90.00000	Latitude of true scale in a map projection. Only present when MAP_PROJECTION is PS.
FALSE_EASTING	9	= -200000000 through +200000000	Value added to all "x" values in the rectangular coordinates for a map projection. Frequently assigned to eliminate

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
			negative numbers. Expressed in the unit of measure identified in the ProjLinearUnitsGeoKey. Only present when MAP_PROJECTION is PS.
FALSE_NORTHING	9	= -200000000 through +200000000	Value added to all "y" values in the rectangular coordinates for a map projection. Frequently assigned to eliminate negative numbers. Expressed in the unit of measure identified in the ProjLinearUnitsGeoKey. Only present when MAP_PROJECTION is PS.
GRID_CELL_SIZE_REFLECTIVE	5	= 0.00 - 120.00 meters, in increments of 0.01 meters 25.00 – 60.00 (IAS / LPGS)	Grid cell size used in creating the image for the reflective band.
GRID_CELL_SIZE_THERMAL	5	= 0.00 - 120.00 meters, in increments of 0.01 meters 25.00 – 60.00 (IAS / LPGS)	Grid cell size used in creating the image for the thermal band, if part of the product
ORIENTATION	10	= “NORTH_UP”	Orientation used in creating the image.
RESAMPLING_OPTION	28	= “CUBIC_CONVOLUTION”	Resampling option used in creating the image.
MAP_PROJECTION_L0RA	3	= “PS” (Polar Stereographic) = ”UTM” (Universal Transverse Mercator) = “HOM” (Hotine Oblique Mercator) = ”SOM” (Space Oblique Mercator) = ”NA” (Not applicable)	L0Ra map projection selectively applied to High Density Tapes (HDTs) based on geographic location. Used for processed archive data.
END_GROUP	21	= PROJECTION_PARAMETERS	End of projection parameters group.
END_GROUP	148	L1_METADATA_FILE	End of the L1 Metadata file level group.
END			Required standalone parameter signifying the file end.

Table 3-3. L1 Metadata File

3.1.4 L1 Angle Coefficients File

The L1 angle coefficients file can be created during product generation and contains metadata and coefficients that allow solar and satellite viewing angles to be calculated. Table 3-4 lists the full contents of the L1 angle coefficients file. It is not provided for

Thematic Mapper – Archive Format (TM-A) products. The angle coefficients file is text in the ODL format. Refer to http://landsat.usgs.gov for information on using the L1 angle coefficient file.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
GROUP	= FILE_HEADER	The beginning of the file header ODL group.
LANDSAT_SCENE_ID	TM = “LT#ppprrrYYYYDDDGGGVV”	The unique Landsat scene identifier.
SPACECRAFT_ID	TM = “L#_TM”	Spacecraft from which the data were captured.
WRS_PATH	= 1 – 233	WRS path number for the corresponding scene.
WRS_ROW	= 1 – 248	WRS row number for the corresponding scene.
MODE	= “SLC_ON” = “SLC_OFF”	Indicates whether the scan line corrector is “on” or “off” for this scene.
FIRST_SCAN_DIRECTION	= “F” = “R”	Indicates which direction the first scan is going (forward or reverse).
NUMBER_OF_BANDS	TM = 1 – 7	Number of bands contained in the angle coefficient file.
BAND_LIST	TM = (1,2,3,4,5,6,7)	List of spectral bands contained in the angle coefficient file. The number of bands listed is specified by the NUMBER_OF_BANDS parameter.
END_GROUP	= FILE_HEADER	The end of the file header ODL group.
GROUP	= PROJECTION	The beginning of the projection ODL group.
ELLIPSOID_AXES	= (Semi-major, Semi-minor)	WGS84 ellipsoid semi-major and semi-minor axes in meters.
MAP_PROJECTION	= “UTM“ = “PS“	The map projection used in creating the image. UTM or PS.
PROJECTION_UNITS	= “METERS”	Map projection units, which are always METERS.
DATUM	= “WGS84”	The datum used in creating the image.
ELLIPSOID	= “WGS84”	The ellipsoid used in creating the image.
UTM_ZONE	= 1 – 60	UTM zone number (1 – 60). Field is absent for non-UTM projections.
PROJECTION_PARAMETERS	= (P_1 … P_{15})	General Cartographic Transformation Package (GCTP) map projection parameters array with 15 double precision floating point parameters. This is all zeros for UTM. Polar stereographic includes ellipsoid axes, false easting and northing (both 0), latitude of true scale (+/- 71) and the vertical axis longitude (also 0).

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
UL_CORNER	= (X, Y)	L1TP upper-left corner map projection coordinates in meters (doubles).
UR_CORNER	= (X, Y)	L1TP upper-right corner map projection coordinates in meters (doubles).
LL_CORNER	= (X, Y)	L1TP lower-left corner map projection coordinates in meters (doubles).
LR_CORNER	= (X, Y)	L1TP lower-right corner map projection coordinates in meters (doubles).
END_GROUP	= PROJECTION	The end of the projection ODL group.
GROUP	= EPHEMERIS	The beginning of the ephemeris ODL group.
EPHEMERIS_EPOCH_YEAR	= YYYY	Year of ephemeris starting time epoch (integer).
EPHEMERIS_EPOCH_DAY	= DDD	Day of year of ephemeris epoch (integer).
EPHEMERIS_EPOCH_SECONDS	= Seconds	Seconds of day of ephemeris epoch (double).
NUMBER_OF_POINTS	= 1 – 99999	Number of ephemeris points contained in the next four parameter fields.
EPHEMERIS_TIME	= ($time_1$ … $time_N$)	Array of double precision ephemeris sample time offsets (from epoch) in seconds.
EPHEMERIS_ECEF_X	= (X_1 … X_N)	Array of double precision ephemeris samples Earth Centered Earth Fixed (ECEF) X coordinates in meters.
EPHEMERIS_ECEF_Y	= (Y_1 … Y_N)	Array of double precision ephemeris samples ECEF Y coordinates in meters.
EPHEMERIS_ECEF_Z	= (Z_1 … Z_N)	Array of double precision ephemeris samples ECEF Z coordinates in meters.
END_GROUP	= EPHEMERIS	The end of the ephemeris ODL group.
GROUP	= SOLAR_VECTOR	The beginning of the solar vector ODL group.
SOLAR_EPOCH_YEAR	= YYYY	Year of solar start time (integer).
SOLAR_EPOCH_DAY	= DDD	Day of year of solar start time (integer).
SOLAR_EPOCH_SECONDS	= Seconds	Seconds of day of solar start time (double).
EARTH_SUN_DISTANCE	= Distance	Measurement of the earth to sun distance at the particular day and time of imagery acquisition. Astronomical Unit (AU) of measurement.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
NUMBER_OF_POINTS	= 1 – 99999	Number of solar vector points contained in the next four parameter fields.
SAMPLE_TIME	= ($time_1$ … $time_N$)	Array of double precision solar vector sample time offsets (from epoch) in seconds.
SOLAR_ECEF_X	= (X_1 … X_N)	Array of double precision solar vector samples ECEF X direction.
SOLAR_ECEF_Y	= (Y_1 … Y_N)	Array of double precision solar vector samples ECEF Y direction.
SOLAR_ECEF_Z	= (Z_1 … Z_N)	Array of double precision solar vector samples ECEF Z direction.
END_GROUP	= SOLAR_VECTOR	The end of the solar vector ODL group.
GROUP	= SCAN_TIME_POLY	The beginning of the Rational Polynomial Coefficients (RPC) scan time ODL group. The "##" corresponds to the scan direction (0,1).
SCAN_TIME_POLY_NCOEFF	= 3 = 4	The number of coefficients to use to map the scan time polynomial.
SCAN_TIME_POLY_NUMBER_DIRECTIONS	= 2	The number of scan directions.
SCAN_TIME##_MEAN_ACTIVESCAN	= Mean scan time	Mean time of the scan line per direction.
SCAN_TIME##_MEAN_EOL	= Mean end of line time	Mean time of the end of the scan line per direction.
SCAN_TIME##_POLY_COEFF	= (coeff, coeff, coeff, coeff)	The scan time polynomial coefficients per direction. The number of coefficients is always 4. If SCAN_TIME_POLY_NCOEFF is 3, the fourth coefficient is zero.
END_GROUP	= SCAN_TIME-POLY	The end of the Scan Time Poly group.
GROUP	= RPC_BAND##	The beginning of the RPC Band ## ODL group. The "##" corresponds to the band number (1 – 11). This group is repeated for every band that is present.
BAND##_LINES_PER_SCAN	= 1 – 16	Number of data lines in a scan line.
BAND##_NUMBER_OF_DIRECTIONS	= 1 – 2	Number of scan directions.
BAND##_NUM_L1T_LINES	= 1 – 99999	Number of lines in the L1TP product.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
BAND##_NUM_L1T_SAMPS	= 1 – 99999	Number of samples in the L1TP product.
BAND##_NUM_L1R_LINES	= 1 – 99999	Number of lines in the L1R product.
BAND##_NUM_L1R_SAMPS	= 1 – 99999	Number of samples in the L1R product.
BAND##_PIXEL_SIZE	= L1TP pixel size	L1TP pixel size in meters.
BAND##_START_TIME	= Start Time	L1R image start time in seconds from the ephemeris epoch.
BAND##_LINE_TIME	= Seconds per line	L1R image line time increment in seconds.
BAND##_MEAN_HEIGHT	= Mean Height	Mean height offset over the scene for the RPC angle model (double).
BAND##_MEAN_L1R_LINE_SAMP	= (Line, Sample)	Mean L1R line and sample offsets for the RPC angle model (doubles).
BAND##_MEAN_L1T_LINE_SAMP	= (Line, Sample)	Mean L1TP line and sample offsets for the RPC angle model (doubles).
BAND##_MEAN_SAT_VECTOR	= (X, Y, Z)	Mean satellite view vector for the RPC angle model (doubles).
BAND##_SAT_X_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the satellite view vector X coordinate.
BAND##_SAT_X_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of double precision denominator polynomial coefficients for the satellite view vector X coordinate.
BAND##_SAT_Y_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the satellite view vector Y coordinates.
BAND##_SAT_Y_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of double precision denominator polynomial coefficients for the satellite view vector Y coordinate.
BAND##_SAT_Z_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the satellite view vector Z coordinates.
BAND##_SAT_Z_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of double precision denominator polynomial coefficients for the satellite view vector Z coordinate.
BAND##_MEAN_SUN_VECTOR	= (X, Y, Z)	Mean sun vector for the RPC angle model (doubles).

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
BAND##_SUN_X_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the sun vector X coordinate.
BAND##_SUN_X_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of denominator polynomial coefficients for the sun vector X coordinate.
BAND##_SUN_Y_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the sun vector Y coordinates.
BAND##_SUN_Y_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of double precision denominator polynomial coefficients for the sun vector Y coordinates.
BAND##_SUN_Z_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the sun vector Z coordinates.
BAND##_SUN_Z_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of double precision denominator polynomial coefficients for the sun vector Z coordinates.
BAND##_DIR##_MEAN_HEIGHT	= Mean Height	Mean height offset for the scan direction ## L1TP to L1R RPC model. The ## behind the DIR denotes the scan direction. This field and the following six fields are repeated for each scan direction present in the list for the current band and each following band.
BAND##_DIR##_MEAN_L1R_LINE_SAMP	= (Line, Sample)	Mean L1R line and sample offsets for the DIR## L1TP to L1R RPC model (doubles).
BAND##_DIR##_MEAN_L1T_LINE_SAMP	= (Line, Sample)	Mean L1TP line and sample offsets for the DIR## L1TP to L1R RPC model (doubles).
BAND##_DIR##_LINE_NUM_COEF	= (a_0 … a_4)	Array (five elements) of numerator polynomial coefficients for the DIR## L1R line RPC model (doubles).
BAND##_DIR##_LINE_DEN_COEF	= (b_1 … b_4)	Array (four elements) of denominator polynomial coefficients for the DIR## L1R line RPC model (doubles).
BAND##_DIR##_SAMP_NUM_COEF	= (c_0 … c_4)	Array (five elements) of numerator polynomial coefficients for the DIR## L1R sample RPC model (doubles).

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
BAND##_DIR##_SAMP_DEN_COEF	= (d_1 … d_4)	Array (four elements) of denominator polynomial coefficients for the DIR## L1R sample RPC model (doubles).
END_GROUP	= RPC_BAND##	The end of the RPC BAND ## ODL group. This group is followed by the next RPC_BAND## ODL group (if present).

Table 3-4. Angle Coefficients File

3.1.5 GCPs File

The GCP file included with an L1TP product is written in ASCII format and contains a header followed by records, one on each line. Each record corresponds to a single GCP. Each record has eight column headings and looks similar to Table 3-5.

Example GCP Output File

Sat. Mar. 1, 2014 LANDSAT 5 Time: 04:27
Image Assessment System
GCP Residual Report

WOID: L10217747 Path/Row: 025 / 029

LOR Reference Image: L51EDC1011320160100_HDF.140601021
Acquisition Date: Nov 16, 2011

Band Number: 5

GLS date for each WRS-2 path/row used:

Path	Row	Date
025	029	2001-08-08

Point_ID	Latitude (deg)	Longitude (deg)	Height (meters)	Across Scan Residual (meters)	Along Scan Residual (meters)	Residual In y dir (meters)	Residual in x dir (meters)
0250290001_01	44.255715	-90.497797	272.000	-5.994	2.685	-6.359	1.636
0250290002_01	44.788274	-89.718681	318.000	-4.054	2.217	-4.371	1.504
0250290003_01	44.209159	-90.315026	270.868	-4.448	-0.402	-4.317	-1.146
0250290004_01	44.029828	-90.469141	259.313	-9.172	3.864	-9.690	2.259
0250290005_01	43.897801	-90.957349	195.000	1.044	4.474	0.273	4.585
0250290006_01	44.210944	-90.874078	190.266	-8.718	3.875	-9.242	2.349
0250290007_01	44.951069	-90.568913	347.500	0.207	2.509	-0.216	2.507
0250290009_01	44.341408	-90.563776	260.681	1.467	1.874	1.130	2.093
0250290010_01	44.333481	-90.376712	281.670	8.068	0.926	7.794	2.272
0250290011_01	45.058694	-89.693709	392.753	8.764	-0.402	8.703	1.071

Table 3-5 Example GCP Output File

3.1.6 Verify File

The Geometric Verification Statistics file included with an L1TP product is written in ASCII format and contains a header followed by records, one on each line. Each record

has seven column headings and looks similar to Table 3-6. Each record corresponds to a single GCP marked with a colored dot in the Three Band Verification Browse Image. The contents of the Verify File look similar to Table 3-6.

```
Example Verify  Output File
================================================================================
Mon. Nov. 19 2012                LANDSAT                      Time: 14:19
                           Image Assessment System
                           GEOMETRIC VERIFY Report
================================================================================
Order ID: 0101211162488_00863                          Path / Row - 30 / 36
Reference Image: L51PAC1006293170100_HDF.L1G

Color mapping per rank
----------------------
Rank  1 is Green: total residual <= 0.5
Rank  2 is Cyan: 0.5 < total residual <=  1
Rank  3 is Blue:  1 < total residual <=  2
Rank  4 is Yellow:  2 < total residual <=  3
Rank  5 is Red:  3 < total residual

Percentage of residuals by rank
-------------------------------
Rank   1 -- 90.9%
Rank   2 --  9.1%
Rank   3 --  0.0%
Rank   4 --  0.0%
Rank   5 --  0.0%

       GCP    Latitude    Longitude  Sample   Line     Total    Rank
        ID                           Residual Residual Residual
              (Degree)    (Degree)   (Pixel)  (Pixel)  (Pixel)
-------------------------------------------------------------------
0300360093   35.52519   -102.08660    -0.16      0.02     0.16     1
0300360094   35.52608   -102.05157     0.03     -0.13     0.13     1
0300360095   35.52696   -102.01655     0.22      0.04     0.22     1
0300360096   35.52783   -101.98152    -0.01     -0.20     0.20     1
0300360168   35.49926   -102.08560     0.03      0.10     0.11     1
0300360169   35.50015   -102.05059    -0.24     -0.03     0.25     1
0300360170   35.50103   -102.01558    -0.19      0.01     0.19     1
0300360171   35.50190   -101.98056     0.01     -0.11     0.11     1
0300360172   35.50276   -101.94554    -0.46     -0.01     0.46     1
0300360174   35.50445   -101.87551    -0.02     -0.10     0.10     1
0300360175   35.50528   -101.84048    -0.07     -0.28     0.29     1
0300360176   35.50610   -101.80546     0.28     -0.36     0.45     1
0300360242   35.47243   -102.11961     0.08     -0.19     0.20     1
0300360245   35.47510   -102.01461     0.01      0.01     0.01     1
0300360246   35.47597   -101.97960    -0.10     -0.08     0.13     1
0300360247   35.47683   -101.94460    -0.04     -0.09     0.10     1
0300360248   35.47768   -101.90959     0.02     -0.01     0.02     1
0300360249   35.47852   -101.87458    -0.13      0.08     0.15     1
0300360250   35.47935   -101.83957     0.11     -0.18     0.21     1
0300360251   35.48017   -101.80456     0.24     -0.33     0.41     1
```

Table 3-6. Example Verify File

3.2 NLAPS GeoTIFF File Formats

3.2.1 NLAPS Work Order Report File

The work order report file provides a record of the work executed into a TRAM Product Order. This file is in ASCII format and contains information relative to the processing

performed and the parameters used (e.g., latitudes and longitudes specified in degrees, and heights specified in meters).

The Correction Processing Report file provides a record of the work executed in response to a TRAM Product Order. It is in ASCII format for easy readability, and contains the following information (notes describing units and/or formats are used for latitude, longitude, heights, dates, etc.):

- Product order information
- Processing stage reports
  - Name of the processing stage
  - Start and completion date / time of the processing stage
  - Summary / status information
- Processing stages may include the following:
  - Ingest
  - Precision Modeling
  - DEM Ingest
  - DEM Processing
  - Apply Despike Filter
  - Apply Deband Filter
  - Image Correction
  - Geometric Quality Assessment
  - Radiometric Quality Assessment
  - Product Formatting
- Summary information (e.g., Work order start and stop date / times and total Central Processing Unit (CPU) time)

NLAPS CORRECTION PROCESSING REPORT (Example)

```
---------------------------------

NLAPS CORRECTION PROCESSING REPORT
---------------------------------


NLAPS Version:      4_13_0e22
Work Order:         080090929013100001        Priority:          9
Satellite:          Landsat-5                 Sensor:            TM
Camera Number:      N/A                       Sensor Mode:       N/A

Input Data Ident:   /san/stk1/nlaps/diskIngest/080090929013100001
Input Media Type:   Disk                      File Number:       N/A
Orbit Number:       2399

Processing Level:   Precision Geocorrection   Resampling:        CC
Map Projection:     UTM                       Zone:              38
Earth Ellipsoid:    WGS84                     Panel Effect:      FALSE
```

Product Orient.: Map North Pixel Origin: Center

Projection Params:
6.378137000000000e+06 6.356752314250000e+06 0.000000000000000e+00
0.000000000000000e+00 0.000000000000000e+00 0.000000000000000e+00
0.000000000000000e+00 0.000000000000000e+00 0.000000000000000e+00
0.000000000000000e+00 0.000000000000000e+00 0.000000000000000e+00
0.000000000000000e+00 0.000000000000000e+00 0.000000000000000e+00
Line Spacing: 030.0 Pixel Spacing: 030.0

Path/Strip no.: 166 Start Row no.: 043.0
End Row no.: N/A

Image Lines: 6882 Image Pixels: 7418
Image Orientation: 0.00 deg from N Output Bands: 1234567
Viewing Angle: 0.01 deg Ephemeris Type: PREDICTIVE

Scene center lat: 24.564 deg Scene center long: 45.780 deg
Sun Elevation: 58.29 deg Sun Azimuth: 102.03 deg
Scene center date: 1984 08 13 Scene center time: 06:53:21.6681

Output Media: Disk Output Product Id: N/A
Product Format: GeoTiff Interleaving: BSQ
Catalogued: FALSE

Completion date: 2009 09 29 Completion time: 16:36:13

Termination Status: Successful Completion

==========
DETAILED PROCESSING RESULTS
==========

MODEL REFINEMENT STATISTICS

Number of CPs in model: 25

Error	Mean (m)	RMS (m)	Std Dev (m)
Along Track	0.02	11.19	11.19
Across Track	-0.01	10.34	10.34
Height	0.00	0.82	0.82
Combined	0.02	15.26	15.26

Num	Mark	Kind	Location Lat	Long	Height	Residuals Along	Across	Height	Comb
4189268	Auto	RCP	24.59	45.74	705.53	-0.34	10.49	-0.07	10.50
1423826	Auto	RCP	23.67	46.46	886.57	-1.01	-8.01	-1.13	8.15
4189103	Auto	RCP	25.34	45.10	797.72	-3.06	5.13	-0.69	6.02
4189410	Auto	RCP	23.99	44.79	991.95	-13.41	-2.43	0.33	13.64
4189392	Auto	RCP	23.81	45.63	677.59	-8.57	-20.20	-0.09	21.95
1423312	Auto	RCP	25.19	46.84	680.89	-1.84	-2.91	-0.41	3.46
1423502	Auto	RCP	25.34	45.98	684.34	-13.52	-11.55	-0.03	17.78
1451381	Auto	RCP	24.70	44.97	769.55	9.94	-18.94	2.47	21.53
4176051	Auto	RCP	24.87	46.27	769.07	-14.30	7.95	0.51	16.36
1400328	Auto	RCP	24.30	46.59	761.47	3.14	3.50	0.48	4.73
4176184	Auto	RCP	24.10	46.04	694.36	-1.06	8.80	0.52	8.88
1423410	Auto	RCP	25.10	45.53	713.23	19.01	4.00	-0.25	19.43
1423555	Auto	RCP	24.71	46.73	607.43	17.02	1.65	0.22	17.10
1423590	Auto	RCP	24.49	46.15	658.05	2.71	2.94	0.18	4.00
4175985	Auto	RCP	25.26	46.39	631.22	-6.19	4.75	0.33	7.81
4176279	Auto	RCP	23.74	46.01	680.10	-5.01	8.38	0.56	9.78
1423575	Auto	RCP	24.92	45.87	710.20	-0.55	-14.47	-0.00	14.48
4189232	Auto	RCP	24.78	45.41	734.25	-9.95	-1.95	0.13	10.14
1451616	Auto	RCP	24.37	44.95	863.17	26.92	-3.16	0.39	27.11
4189331	Auto	RCP	24.20	45.40	728.08	-4.58	12.70	-0.57	13.52
4189378	Auto	RCP	23.91	45.18	907.50	-16.25	-0.91	0.07	16.28
1423481	Auto	RCP	23.99	46.37	981.38	12.81	-7.49	-0.86	14.86
1451185	Auto	RCP	25.42	45.50	798.83	-12.21	-13.84	1.06	18.48
4189281	Auto	RCP	24.49	45.29	731.81	12.60	21.19	-1.56	24.70
1451631	Auto	RCP	25.03	45.20	743.37	8.13	14.17	-1.53	16.41

RADIOMETRIC CORRECTION

Algorithm: NASA CPF

Band	Ref Detector	DN to Radiance gain	offset	Default Abs Calib?	Average Gain Coeff.
1	15	0.668706	-1.520000	FALSE	1.483000
2	10	1.317020	-2.840000	FALSE	0.749900
3	2	1.039880	-1.170000	FALSE	0.978900
4	1	0.872588	-1.510000	FALSE	1.082000
5	2	0.119882	-0.370000	FALSE	8.159400

6	4	0.055158	1.237800	TRUE	0.000000
7	15	0.065294	-0.150000	FALSE	14.286600

Band 1 Coefficients (Qcal = (Q - offset) / gain):

Detector	Forward		Backward	
	gain	offset	gain	offset
1	0.997041	-0.166788	1.003230	-1.037930
2	0.988642	0.538642	0.995202	-0.390149
3	0.983499	0.330880	0.988125	-0.305380
4	0.987967	0.677995	0.993673	-0.122499
5	0.990780	0.240924	0.993809	-0.171892
6	0.990719	0.414497	0.995247	-0.229455
7	0.992247	-0.181324	0.993827	-0.353781
8	0.981735	0.731380	0.984617	0.334618
9	0.985237	-0.334397	0.987997	-0.658971
10	0.984981	-1.235080	0.990308	-1.976320
11	0.984596	-0.383532	0.987562	-0.726588
12	0.992761	0.717494	0.997104	0.125648
13	0.991139	-0.657031	0.993839	-0.953968
14	0.996901	-2.116440	1.003100	-2.985210
15	0.987522	0.926554	0.991111	0.476986
16	0.996478	0.946786	1.003110	0.069706

Band 2 Coefficients (Qcal = (Q - offset) / gain):

Detector	Forward		Backward	
	gain	offset	gain	offset
1	0.966013	0.377819	0.987318	-1.577750
2	0.980474	0.466963	1.001530	-1.471860
3	0.968650	0.700510	0.986705	-0.968165
4	0.977171	0.317679	0.996087	-1.412030
5	0.979910	0.718208	0.997600	-0.903251
6	0.980578	0.539450	0.997470	-1.044890
7	0.980245	0.223949	0.996653	-1.275950
8	0.970621	0.364279	0.986127	-1.055330
9	0.991267	0.340162	1.006110	-1.050270
10	0.973679	0.305075	0.992323	-1.409610
11	0.988969	0.271510	1.005370	-1.249250
12	0.978690	0.111136	0.998131	-1.672310
13	0.987854	0.161662	1.005000	-1.410820
14	0.970990	0.854750	0.988872	-0.786657
15	0.979906	0.762195	0.999874	-1.060350
16	0.981591	0.915111	1.002490	-0.982883

Band 3 Coefficients (Qcal = (Q - offset) / gain):

Detector	Forward		Backward	
	gain	offset	gain	offset
1	1.019530	2.095860	1.039960	-0.594715
2	1.010140	1.949250	1.030050	-0.665955
3	1.010860	2.068940	1.029930	-0.453051
4	1.000890	2.152700	1.021180	-0.516327
5	1.013110	2.174130	1.033600	-0.542781
6	0.996306	2.205400	1.016790	-0.479851
7	1.009170	2.007650	1.029050	-0.571014
8	0.998093	1.889610	1.013790	-0.130237
9	1.009700	1.775900	1.027050	-0.546126
10	0.992648	2.030260	1.015660	-0.950857
11	0.998625	1.996620	1.020250	-0.837371
12	1.009710	1.827370	1.031250	-0.944115
13	1.017610	1.502160	1.039320	-1.340770
14	1.007350	1.824820	1.027740	-0.836445
15	1.020860	2.464360	1.044640	-0.645331
16	1.008860	2.570880	1.030390	-0.239438

Band 4 Coefficients (Qcal = (Q - offset) / gain):

Detector	Forward		Backward	
	gain	offset	gain	offset
1	0.936945	1.550240	0.962337	-1.769380
2	0.924132	2.502810	0.951880	-1.123520
3	0.934846	1.991510	0.957351	-0.942778
4	0.931765	1.386180	0.949665	-0.952484
5	0.934413	1.311990	0.952206	-1.014550
6	0.932654	1.712240	0.953976	-1.070680
7	0.944152	1.260210	0.960027	-0.828482
8	0.922964	1.725490	0.943192	-0.883521
9	0.940736	1.728650	0.962629	-1.115520
10	0.932836	2.269000	0.951543	-0.176606
11	0.934108	1.539600	0.953752	-1.012040
12	0.930562	1.784310	0.952179	-1.001080
13	0.928130	1.049210	0.948346	-1.551040
14	0.929305	1.943850	0.954050	-1.273410
15	0.936383	1.532780	0.957961	-1.222890
16	0.939977	2.194590	0.967493	-1.345340

Band 5 Coefficients (Qcal = (Q - offset) / gain):

Detector	Forward		Backward	
	gain	offset	gain	offset
1	0.984037	-0.279681	0.984485	-0.671829
2	0.985020	-0.795233	0.988606	-1.839910
3	0.978297	-0.510279	0.978121	-0.778441
4	0.983327	-0.874138	0.985901	-1.767180
5	0.978325	-0.402108	0.979210	-0.894588
6	0.976417	-0.579295	0.980556	-1.753710
7	0.980722	0.008572	0.982216	-0.520399
8	0.974564	0.092205	0.980379	-1.398960
9	0.993732	0.709737	0.998224	-0.533127
10	0.957363	0.094792	0.961091	-1.034390
11	0.965758	0.091964	0.968889	-0.884978
12	0.982942	-0.053410	0.990849	-2.085110
13	0.955806	0.518955	0.959030	-0.496924
14	0.974732	-0.176792	0.982496	-2.241240
15	0.969873	-0.248904	0.972263	-1.193500
16	0.979748	-0.112306	0.988400	-2.314080

Band 6 Coefficients (Qcal = (Q - offset) / gain):

Detector	Forward		Backward	
	gain	offset	gain	offset
1	0.998992	0.256184	0.998992	0.256184
2	0.996739	0.632445	0.996739	0.632445
3	1.010460	-2.029880	1.010460	-2.029880
4	0.993806	1.145260	0.993806	1.145260

Band 7 Coefficients (Qcal = (Q - offset) / gain):

Detector	Forward		Backward	
	gain	offset	gain	offset
1	0.933641	0.528931	0.938408	-0.221642
2	0.935909	0.049220	0.939324	-0.502637
3	0.927093	0.337670	0.930785	-0.272783
4	0.927238	0.514392	0.931516	-0.185765
5	0.926957	0.386971	0.931432	-0.348479
6	0.941456	0.295493	0.945620	-0.383702
7	0.920703	0.590684	0.924509	-0.032749
8	0.936790	0.371118	0.941993	-0.461006
9	0.924102	0.639311	0.929504	-0.235144
10	0.929947	0.308505	0.935604	-0.590204

11	0.916035	0.594275	0.921585	-0.295131
12	0.939992	0.947434	0.946348	-0.066852
13	0.934142	0.493432	0.940311	-0.505802
14	0.932896	0.831315	0.939841	-0.277913
15	0.922025	0.702901	0.929388	-0.464046
16	0.934385	0.833005	0.941113	-0.235215

==========

DEM PROCESSING

Elevation Correction Applied: Fine DEM
LineSpacing: 3.000000000000000e+00
LineSpacingUnits: seconds
PixelSpacing: 3.000000000000000e+00
PixelSpacingUnits: seconds

DEM Files Used
---
n23e044
n23e045
n23e046
n24e044
n24e045
n24e046
n25e044
n25e045
n25e046

==========

RADIOMETRIC QUALITY ASSESSMENT

NOTE:
Mean, Std.Dev, Striping are in DN's (Digital Numbers).

Band	Chip Location		Chip Size		Mean	Std Dev	Striping
	Line	Pixel	Lines	Pixels			
1	1197.60	1268.00	128	128	1.53	0.014	0.0034
1	2394.20	2535.00	128	128	1.33	0.043	0.0032
1	3590.80	3802.00	128	128	1.43	0.026	0.0036
1	4787.40	5069.00	128	128	1.56	0.014	0.0044

2	1197.60	1268.00	128	128	0.92	0.021	0.0018
2	2394.20	2535.00	128	128	0.88	0.012	0.0012
2	3590.80	3802.00	128	128	0.89	0.021	0.0008
2	4787.40	5069.00	128	128	0.95	0.011	0.0013
3	1197.60	1268.00	128	128	1.29	0.025	0.0024
3	2394.20	2535.00	128	128	1.41	0.020	0.0011
3	3590.80	3802.00	128	128	1.35	0.067	0.0021
3	4787.40	5069.00	128	128	1.31	0.030	0.0012
4	1197.60	1268.00	128	128	1.26	0.023	0.0022
4	2394.20	2535.00	128	128	1.41	0.027	0.0017
4	3590.80	3802.00	128	128	1.36	0.065	0.0014
4	4787.40	5069.00	128	128	1.33	0.052	0.0022
5	1197.60	1268.00	128	128	2.54	0.066	0.0068
5	2394.20	2535.00	128	128	2.61	0.024	0.0089
5	3590.80	3802.00	128	128	2.59	0.039	0.0072
5	4787.40	5069.00	128	128	2.55	0.085	0.0105
6	300.00	318.40	128	128	2.01	0.018	0.0014
6	599.00	635.80	128	128	2.07	0.015	0.0016
6	898.00	953.20	128	128	2.08	0.007	0.0024
6	1197.00	1270.60	128	128	1.97	0.009	0.0010
7	1197.60	1268.00	128	128	1.46	0.026	0.0015
7	2394.20	2535.00	128	128	1.68	0.035	0.0039
7	3590.80	3802.00	128	128	1.59	0.093	0.0038
7	4787.40	5069.00	128	128	1.47	0.060	0.0034

==========

PRODUCT FORMATTING

Product Scene Center Location (lat/long) : 24.564 45.780
Product Scene Center Date/Time (yyyy mm dd): 1984 8 13 06:53:21.6681

Product Extent:

Lat: 25.50 ---------- Lat: 25.49
Long: 44.68 Long: 46.89
North: 2820135.00 North: 2820135.00
East: 467685.00 East: 690195.00
| |
| |
| |
| |
| |
| |
Lat: 23.63 Lat: 23.62
Long: 44.68 Long: 46.86

North: 2613705.00 North: 2613705.00
East: 467685.00 ---------- East: 690195.00

==========

EXECUTION INFORMATION

Stage	Start	End	CPU
Ingest	Tue Sep 29 16:24:01 2009	Tue Sep 29 16:25:21 2009	67.13
ModelRefiner	Tue Sep 29 16:25:26 2009	Tue Sep 29 16:27:27 2009	66.15
MemEffect	Tue Sep 29 16:27:49 2009	Tue Sep 29 16:28:18 2009	23.26
DemIngest	Tue Sep 29 16:27:30 2009	Tue Sep 29 16:27:34 2009	1.18
WarpDem	Tue Sep 29 16:27:36 2009	Tue Sep 29 16:27:49 2009	19.15
ImCorr	Tue Sep 29 16:28:19 2009	Tue Sep 29 16:35:46 2009	824.39
RadQa	Tue Sep 29 16:35:47 2009	Tue Sep 29 16:35:48 2009	0.19
Output	Tue Sep 29 16:35:50 2009	Tue Sep 29 16:36:11 2009	4.80
Catalog	Tue Sep 29 16:36:12 2009	Tue Sep 29 16:36:12 2009	0.17

			1006.42

Section 4 Product Packaging

L1 products are available for distribution via Hypertext Transfer Protocol (HTTP) download. The following provides information on each distribution method for the available L1 product formats.

4.1 Electronic Transfer

Products available via electronic transfer also include the L1 volume descriptor (readme file) with the same file names as listed. When data are packaged and ready for distribution, they are stored in directories on the production online cache for retrieval.

The LPGS GZips (compression) all standard products for distribution. Each individual file within the scene is GZipped.

Section 5 Software Tools

5.1 ODL Parser

The University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) originally implemented the ODL parser (Version 1.0) incorporated into the Science Data Processing (SDP) Toolkit. The Jet Propulsion Laboratory (JPL) enhanced the ODL parser in building their Planetary Data System. IAS modified this enhanced version, available at http://pds.nasa.gov/tools/. LPGS uses this IAS-modified version.

The IAS-modified version should be particularly useful to those operating in a non-HDF-Earth Observing System (EOS) environment. The software stands alone and reads the L0Rp or L1 metadata external elements and the CPF.

Appendix A Projection Parameters

This appendix contains the map projection parameters used in the L1 products and the USGS Projection Parameters (Table A-2).

Project Name	Mnemonic
Polar Stereographic	PS
Universal Transverse Mercator	UTM

Table A-1. L1 Output Product Projection Parameters

Projection Name Mnemonic	Array Element							
	1	2	3	4	5	6	7	8
PS	SMajor	SMinor			LongPol	TrueScale	FE	FN
UTM	Lon/Z	Lat/Z						

Table A-2. USGS Projection Parameters – Projection Transformation Package Projection Parameters (Elements 1-8)

Projection Name Mnemonic	Array Element						
	9	10	11	12	13	14	15
PS							
UTM							

Table A-3. USGS Projection Parameters - Projection Transformation Package Projection Parameters (Elements 9-15)

Where	Lon/Z	=	Longitude of any point in the UTM zone or zero.
	Lat/Z	=	Latitude of any point in the UTM zone or zero.
	SMajor	=	Semi-major axis of the ellipsoid. If zero, Clarke 1866 in meters is assumed.
	SMinor	=	Eccentricity squared of the ellipsoid if less than zero. If zero, a spherical form is assumed. If greater than zero, the semi-major axis of the ellipsoid.
	Sphere	=	Radius of the reference sphere. If zero, 6370997 meters is used.
	Stdpar	=	Latitude of the standard parallel.
	Stdpr1	=	Latitude of the first standard parallel.
	Stdpr2	=	Latitude of the second standard parallel.
	CentMer	=	Longitude of the central meridian.
	OriginLat	=	Latitude of the projection origin.
	FE	=	False easting in the same units as the semi-major axis.
	FN	=	False northing in the same units as the semi-major axis.
	LongPol	=	Longitude down below the pole of the map.
	TrueScale	=	Latitude of the true scale.
	Factor	=	Scale factor at the central meridian (TM) or center of projection (Oblique Mercator Type A (OMA) / Oblique Mercator Type B (OMB)).
	CentLon	=	Longitude of the center of projection.
	CenterLat	=	Latitude of the center of projection.
	Height	=	Height of the perspective point.
	Long1	=	Longitude of the first point on the center line.
	Long2	=	Longitude of the second point on the center line.
	Lat1	=	Latitude of the first point on the center line.
	Lat2	=	Latitude of the second point on the center line.
	AziAng	=	Azimuth angle east and north of the center line.
	AzmthPt	=	Longitude of point on the central meridian where azimuth occurs.
	Satnum	=	Landsat satellite number.
	Path	=	Landsat path number (use WRS-1 for Landsat 1, 2, and 3, and WRS-2 for Landsat 4, 5, 6, and 7).
	Shapem	=	Oval shape parameter m.
	Shapen	=	Oval shape parameter n.
	Angle	=	Oval rotation angle.

Table A-4. USGS Projection Parameters Key

Note: All array elements with blank fields are set to zero. All angles (latitudes, longitudes, azimuths, etc.) are entered in packed degrees / minutes / seconds (DDDMMMSSS.SS) format.

References

Please see http://landsat.usgs.gov/tools_acronyms_ALL.php for a list of acronyms.

USGS/EROS. LSDS-43. Landsat 4-5 Thematic Mapper (TM) Calibration Parameter File (CPF) Definition.

USGS/EROS. LSDS-280. Landsat Thematic Mapper (TM) Level 0 Reformatted Product (L0Rp) Data Format Control Book (DFCB).

USGS/EROS. LSDS-283. National Land Archive Production System (NLAPS) Systematic Format Description Document.

USGS/EROS. LSDS-293. Landsat Data Management Policy.

USGS/EROS. LSDS-524. Landsat Metadata Description Document (LMDD).

505-10-36. Earth Science Data and Information System (ESDIS) Project Mission Specific Requirements for the Landsat 7 Mission L1 Processing. November 1998.

GeoTIFF Specification. Revision 1.0. (http://www.remotesensing.org/geotiff/spec/geotiffhome.html).

JPL D-7669, Part 2, Planetary Data System Standards Reference, Object Description Language Specification and Usage. Version 3.7. March 2006.

National Land Archive Production System (NLAPS) Precision and Terrain Formats Description Document.
http://eros.usgs.gov/ecms/documents/guides/nlapsgeo2.doc

National Land Archive Production System (NLAPS) Systematic Format Description Document – U.S. Geological Survey Format Specifications for Geometrically Corrected Landsat L1 Digital Data Products. July 2000.