

Department of the Interior
U.S. Geological Survey

**LANDSAT 8 (L8)
FULL RESOLUTION BROWSE (FRB)
DATA FORMAT CONTROL BOOK (DFCB)**

Version 6.0

February 2017



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FULL RESOLUTION BROWSE (FRB)
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February 2017

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Executive Summary

Landsat 8 is a remote sensing mission, which provides data continuity to the Landsat satellite series global multispectral data collection and distribution. Landsat 8 is a satellite and ground based capabilities collection that provides the following:

- Global, moderate-resolution, multispectral data collection
- Long-term Landsat 8 data archiving
- Web-enabled access
- Continued Landsat International Cooperators (ICs) support
- Level 0 and Level 1 data products

This Full Resolution Browse (FRB), also known as LandsatLook, Data Format Control Book (DFCB) describes the general algorithm for generating browse images, the file formats used for delivery, and the compression methods used.

Document History

Document Number	Document Version	Publication Date	Change Number
LDCM-DFCB-007	Version 1.0	February 2010	CCR# 117
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LSDS-833	Version 6.0	February 2017	CR 13479

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Section 1 Introduction

1.1 Purpose

This Data Format Control Book (DFCB) describes the detailed format of the Landsat 8 (L8) browse imagery. The definition of a browse image has changed greatly since the Earth Resources Observation and Science (EROS) Center first started to produce imagery. Early browse images were solely defined by two criteria: 1) their small file size and 2) their ability to permit a user to visually recognize the area covered and to assess overall image cloud cover. With the growth of Google™ Earth and other web mapping applications, the original intent of browse has evolved from use as a tool for image selection to a visual entity that can also serve for mapping and interpretation.

Landsat 8 browse images are created for quick and efficient image selection and for visual interpretation. The following three criteria are critical to meet user needs for Landsat 8 browse images:

- Provide a “small” browse definition for quick delivery, particularly for large areas
- Provide full spatial resolution browse for local area evaluation
- Provide browse that is geo-registered and Geographical Information Systems (GIS)-ready

1.2 Scope

This document describes the general algorithm for generating browse images, the file formats used for delivery, and the compression methods used.

1.3 Document Organization

This document contains the following sections:

- Section 1 contains an introduction.
- Section 2 describes the generation of browse images from the Landsat Level 1 product.
- Section 3 describes the file formats used for browse delivery.
- Section 4 describes the compression methods used for browse delivery.
- Section 5 describes the use of the Open Geospatial Consortium (OGC) Web Mapping Service (WMS) for browse delivery.
- Appendix A provides a sample of the GetCapabilities Output file.
- The References section contains a list of reference documents.

Section 2 Browse Generation

2.1 Assumptions

Level 1 Product Generation System (LPGS) generates browse images from the Level 1 product. The browse generation assumes the following about the Level 1 product:

- The reflective Operational Land Imager (OLI) bands are 30-meter resolution and are stored as 16-bit signed integers that can be linearly scaled to the Top of Atmosphere (TOA) reflectance.
- The Thermal Infrared Scanner (TIRS) bands are resampled to 30-meter resolution and are stored as 16-bit signed integers that can be linearly scaled to the TOA brightness temperature.
- The LPGS generates a 16-bit Quality Band (QB) (pixel level metadata) as part of the Level 1 product.

Up to five browse files may be associated with each scene:

- OLI Full Resolution Browse (FRB): Three bands, 8-bits per band; referred to as the LandsatLook natural color image.
- OLI Reduced Resolution Browse (RRB): A reduced resolution version of the FRB.
- TIRS FRB: One band, 8-bit grayscale; referred to as the LandsatLook thermal image.
- TIRS RRB: A reduced resolution version of the FRB.
- QB FRB: An 8-bit version of the 16-bit QB associated with the Level 1 product.

2.2 Method

The OLI browse (or LandsatLook natural color) image is generated by extracting three bands from the Level 1 product: Band 6 (1610 nm), Band 5 (865 nm), and Band 4 (655 nm) for the red, green, and blue components of the browse, respectively. These bands correspond to Bands 5, 4, and 3 used for the Landsat Enhanced Thematic Mapper Plus (ETM+) browse. The browse data retains full spatial resolution (30 meters) and retains the map projection of the source data (normally polar stereographic for Antarctic scenes and Universal Transverse Mercator (UTM) elsewhere). Radiometrically, each band is scaled to 8-bits per pixel with a gamma stretch:

$$DN_B = 255 * P_p^{(1/\text{gamma})}$$

where P_p is the TOA reflectance and $\text{gamma} = 2.0$. The three bands are then combined to generate a 24-bit color image, which is stored as a Joint Photographic Experts Group (JPEG) compressed Geographic Tagged Image File Format (GeoTIFF) with a quality of 75 percent. This GeoTIFF image is both the source data for the WMS (see Table 2-1) and available for direct download as the “full resolution browse”. This file is typically about six megabytes in size, although the exact size varies depending on the compression.

The TIRS browse (or LandsatLook Thermal image) is generated by extracting Band 10 (10.8 um) from the Level 1 product, converting to brightness temperature (using the parameters from the Level 1 product metadata file), and scaling to an 8-bit grayscale image with a linear stretch, clipping at -40 and 50 degrees Celsius. The browse data retains full spatial resolution (30 meters) and retains the map projection of the source data (normally polar stereographic for Antarctic scenes and UTM elsewhere). The resulting image is stored as a JPEG compressed GeoTIFF with a quality of 75 percent. This GeoTIFF image is both the source data for the WMS and available for direct download as the “full resolution browse”. This file is typically about seven megabytes in size, although the exact size varies depending on the compression.

Two additional JPEG images are generated from the full resolution OLI and TIRS browse by scaling the width to 1024 pixels and the height to preserve the original aspect ratio. The scaling is performed with the gdal_translate utility, using the –outsize option. These images are copied to the Earth Explorer browse directory for use as a “quick look” image, similar to the previous browse images of Landsat 1–7. The OLI file is approximately 250 kilobytes in size, while the TIRS file is approximately 89 kilobytes in size.

The 8-bit QB is generated from the 16-bit QB in the Level 1 product by extracting a subset of the bit fields. Table 2-1 displays the exact layout of the bit fields. The 8-bit QB is stored as a colormapped GeoTIFF with deflate compression.

16-Bit Quality (QA) Band		8-Bit Quality (QA) Band		
Bit	Description	Bit	Description	Color
0	Designated Fill	0	Designated Fill	
1	Dropped Frame	1	Dropped Frame	
2	Terrain Occlusion	2	Terrain Occlusion	
3	Reserved	3	Water*	
4	Water Confidence	4	Vegetation*	
5		5	Snow/Ice*	
6	Reserved for cloud shadow	6	Cirrus*	
7		7	Cloud*	
8	Vegetation Confidence	*Set for highest confidence value (11)		
9				
10	Snow/Ice Confidence			
11				
12	Cirrus Confidence			
13				
14	Cloud Confidence			
15				

Table 2-1. Bit Fields for Pre-Collection

The confidence levels are as follows:

- 00 = None or unset
- 01 = 0–33 percent confidence
- 10 = 34–66 percent confidence
- 11 = 67–100 percent confidence

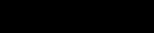






16-Bit Quality (QA) Band		8-Bit Quality (QA) Band		
Bit	Description	Bit	Description	Color
0	Designated Fill	0	Designated Fill	
1	Terrain Occlusion	1	Terrain Occlusion	
2	Radiometric Saturation	2	Radiometric Saturation*	
3		3	Cloud*	
4	Cloud	4	Cloud Shadow	
5	Cloud Confidence	5	Snow/Ice*	
6		6	Cirrus*	
7	Cloud Shadow	7		
8		*Set for highest confidence value (11)		
9	Snow/Ice			
10				
11	Cirrus Confidence			
12				
13				
14				
15				

Table 2-2. Bit Fields for Collection 1

The browse images and 8-bit QB are generated using the Geospatial Data Abstraction Library (GDAL) toolkit.

Section 3 File Formats

The browse delivery format for the OLI and TIRS (both full and reduced resolution) is the JPEG File Interchange Format (JFIF), version 1.01. The file name consists of the following:

OLI browse = <ID> followed by a “.jpg” extension.
For example, LC80380292009269XXX00.jpg.

TIRS browse = <ID>_TIRS followed by a “.jpg” extension.
For example, LC80380292009269XXX00_TIRS.jpg.

QB browse = <ID>_QB followed by a “.jpg” extension.
For example, LC80380292009269XXX00_QB.jpg.

For collection 1 data, the ID is the Landsat Product Identifier, which has the following format:

LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX

Where:

L = Landsat

X = Sensor (O = OLI only, T = TIRS only, C = OLI and TIRS)

S = Satellite (“08” = Landsat 8)

LLLL = Processing correction level

“L1TP”: Precision Terrain

“L1GT”: Systematic Terrain

“L1GS”: Systematic

PPP = WRS path

RRR = WRS row

YYYYMMDD = Acquisition year (YYYY) / Month (MM) / Day (DD)

yyymmdd = Processing year (yyyy) / Month (mm) / Day (dd)

CC = Collection number (“01”)

TX = Collection category: (“RT” for Real-Time, “T1” for Tier 1 or “T2” for Tier 2)

For pre-collection 1 data, the ID is the Landsat Scene Identifier, which has the following format:

LXSPPPRRRYYYYDDDGSIVV

Where:

L = Landsat

X = Sensor (O = OLI only, T = TIRS only, C = OLI and TIRS)

S = Satellite

PPP = WRS Path

RRR = WRS Row

YYYY = Year of Acquisition
DDD = Day of Acquisition Year
GSI = Ground Station Identifier
VV = Version

The GIS-ready bundle is distributed as a zip file containing all three GeoTIFF files. Info-ZIP creates the zip file. An example list of the zip file is shown as follows:

```
Archive: LC08_L1GT_228083_20160112_20161006_01_T2.zip
  Length      Date    Time    Name
-----
  6169001  10-06-2016  10:44    LC08_L1GT_228083_20160112_20161006_01_T2.tif
  1373436  10-06-2016  10:44    LC08_L1GT_228083_20160112_20161006_01_T2_QB.tif
  2444985  10-06-2016  10:44    LC08_L1GT_228083_20160112_20161006_01_T2_TIR.tif
-----
  9987422
                        3 files
```

Section 4 Compression

The browse images are compressed using the JPEG compression algorithm with a quality of 75 percent. The 8-bit QB uses deflate compression, which is lossless.

Section 5 WMS Delivery

In addition to the static images, browse is also available as an OGC WMS layer. The base Uniform Resource Locator (URL) of the WMS is http://earthexplorer.usgs.gov/cgi-bin/landsat_8. Each scene is a layer named by the scene ID. The WMS GetCapabilities request can return detailed information about each layer (see Appendix A). The general configuration is as follows:

- Version 1.1.1 of the WMS specification
- Supported map projections:
 - Geographic (latitude / longitude) (EPSG 4326)
 - “Spherical Mercator” (EPSG 3857) used by many popular web mapping applications
 - UTM (zone of center point plus one zone east and west) except for Antarctic scenes
 - Polar stereographic (EPSG 3031) for Antarctic scenes only
- Supported formats:
 - JPEG
 - PNG
 - GeoTIFF

Appendix A Sample GetCapabilities Output

```
<?xml version='1.0' encoding="ISO-8859-1" standalone="no" ?>
<!DOCTYPE WMT_MS_Capabilities SYSTEM
"http://schemas.opengis.net/wms/1.1.1/WMT_MS_Capabilities.dtd"
[
  <!ELEMENT VendorSpecificCapabilities EMPTY>
]> <!-- end of DOCTYPE declaration -->

<WMT_MS_Capabilities version="1.1.1">

<Service>
  <Name>OGC:WMS</Name>
  <Title>Landsat WMS server</Title>
  <Abstract>Landsat WMS server</Abstract>
  <KeywordList>
    <Keyword>Landsat</Keyword>
  </KeywordList>
  <OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/>
  <ContactInformation>
  </ContactInformation>
  <Fees>none</Fees>
  <AccessConstraints>none</AccessConstraints>
</Service>

<Capability>
  <Request>
    <GetCapabilities>
      <Format>application/vnd.ogc.wms_xml</Format>
      <DCPType>
        <HTTP>
          <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Get>
          <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Post>
        </HTTP>
      </DCPType>
    </GetCapabilities>
    <GetMap>
      <Format>image/png</Format>
      <Format>image/tiff</Format>
      <Format>application/x-nitf</Format>
      <Format>image/gif</Format>
      <Format>image/png; mode=24bit</Format>
      <Format>image/jpeg</Format>
      <Format>image/vnd.wap.wbmp</Format>
      <Format>image/svg+xml</Format>
      <DCPType>
        <HTTP>
          <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Get>
          <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Post>
        </HTTP>
      </DCPType>
    </GetMap>
  </Request>
</Capability>

```

```

</GetMap>
<GetFeatureInfo>
  <Format>text/plain</Format>
  <Format>text/html</Format>
  <Format>application/vnd.ogc.gml</Format>
  <DCPType>
    <HTTP>
      <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Get>
      <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Post>
    </HTTP>
  </DCPType>
</GetFeatureInfo>
<DescribeLayer>
  <Format>text/xml</Format>
  <DCPType>
    <HTTP>
      <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Get>
      <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Post>
    </HTTP>
  </DCPType>
</DescribeLayer>
<GetLegendGraphic>
  <Format>image/png</Format>
  <Format>image/gif</Format>
  <Format>image/png; mode=24bit</Format>
  <Format>image/jpeg</Format>
  <Format>image/vnd.wap.wbmp</Format>
  <DCPType>
    <HTTP>
      <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Get>
      <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Post>
    </HTTP>
  </DCPType>
</GetLegendGraphic>
<GetStyles>
  <Format>text/xml</Format>
  <DCPType>
    <HTTP>
      <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Get>
      <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
xlink:href="http://earthexplorer.usgs.gov/cgi-bin/landsat_8?"/></Post>
    </HTTP>
  </DCPType>
</GetStyles>
</Request>
<Exception>
  <Format>application/vnd.ogc.se_xml</Format>
  <Format>application/vnd.ogc.se_inimage</Format>
  <Format>application/vnd.ogc.se_blank</Format>
</Exception>

```



```

<VendorSpecificCapabilities />
<UserDefinedSymbolization SupportSLD="1" UserLayer="0" UserStyle="1"
RemoteWFS="0"/>
<Layer>
  <Name>Landsat_8</Name>
  <Title>Landsat WMS server</Title>
  <Abstract>Landsat WMS server</Abstract>
  <KeywordList>
    <Keyword>Landsat</Keyword>
  </KeywordList>
  <SRS>EPSG:4326</SRS>
  <LatLonBoundingBox minx="-180" miny="-90" maxx="180" maxy="90" />
</Layer>
<Layer>
  <Name>L1GTtir</Name>
  <Title>L1GTtir</Title>
  <Abstract>L1GTtir</Abstract>
  <Layer queryable="0" opaque="0" cascaded="0">
    <Name>LC80390362000140EDC00_TIR</Name>
    <Title>LC80390362000140EDC00_TIR</Title>
    <SRS>EPSG:32611</SRS>
    <SRS>EPSG:32610</SRS>
    <SRS>EPSG:32612</SRS>
    <SRS>EPSG:4326</SRS>
    <SRS>EPSG:3857</SRS>
    <SRS>EPSG:900913</SRS>
    <LatLonBoundingBox minx="-116.494" miny="33.6174" maxx="-113.999"
maxy="35.6235" />
  </Layer>
  <Layer queryable="0" opaque="0" cascaded="0">
    <Name>LC80390362000076EDC00_TIR</Name>
    <Title>LC80390362000076EDC00_TIR</Title>
    <SRS>EPSG:32611</SRS>
    <SRS>EPSG:32610</SRS>
    <SRS>EPSG:32612</SRS>
    <SRS>EPSG:4326</SRS>
    <SRS>EPSG:3857</SRS>
    <SRS>EPSG:900913</SRS>
    <LatLonBoundingBox minx="-116.485" miny="33.6171" maxx="-113.986"
maxy="35.6235" />
  </Layer>
</Layer>
<Layer>
  <Name>L1GTref</Name>
  <Title>L1GTref</Title>
  <Abstract>L1GTref</Abstract>
  <Layer queryable="0" opaque="0" cascaded="0">
    <Name>LC80390362000076EDC00</Name>
    <Title>LC80390362000076EDC00</Title>
    <SRS>EPSG:32611</SRS>
    <SRS>EPSG:32610</SRS>
    <SRS>EPSG:32612</SRS>
    <SRS>EPSG:4326</SRS>
    <SRS>EPSG:3857</SRS>
    <SRS>EPSG:900913</SRS>
    <LatLonBoundingBox minx="-116.485" miny="33.6171" maxx="-113.986"
maxy="35.6235" />
  </Layer>
</Layer>

```

```
<Layer queryable="0" opaque="0" cascaded="0">
  <Name>LC80390362000140EDC00</Name>
  <Title>LC80390362000140EDC00</Title>
  <SRS>EPSG:32611</SRS>
  <SRS>EPSG:32610</SRS>
  <SRS>EPSG:32612</SRS>
  <SRS>EPSG:4326</SRS>
  <SRS>EPSG:3857</SRS>
  <SRS>EPSG:900913</SRS>
  <LatLonBoundingBox minx="-116.494" miny="33.6174" maxx="-113.999"
maxy="35.6235" />
</Layer>
</Layer>
</Layer>
</Capability>
</WMT_MS_Capabilities>
```

References

Please see <https://landsat.usgs.gov/glossary-and-acronyms> for a list of acronyms.

GeoTIFF Format Specification, GeoTIFF Revision 1.0, Specification Version 1.8.2. 28 December 2000. <<http://www.remotesensing.org/geotiff/spec/geotiffhome.html>>

JPEG File Interchange Format, Version 1.02.
<<http://www.w3.org/Graphics/JPEG/jfif3.pdf>>

JPEG Standard (JPEG ISO/IEC 10918-1 ITU-T Recommendation T.81).
<<http://www.w3.org/Graphics/JPEG/itu-t81.pdf>>

Open GIS Consortium, OGC 01-068r3, Web Map Service Implementation Specification, Version 1.1.1, January 16, 2002.
<http://portal.opengeospatial.org/files/?artifact_id=1081&version=1&format=pdf>

Portable Network Graphics (PNG) Specification (Second Edition).
<<http://www.w3.org/TR/2003/REC-PNG-20031110/>>

Netpbm.
<<http://netpbm.sourceforge.net/doc/>>

Geospatial Data Abstraction Library (GDAL).
<<http://www.gdal.org/>>