

ASTER Data, Product L1B (Radiance at Sensor) - How do the ATCOR Calibration Files (*.cal) have to look like?

A. ASTER L1B Product Description:

taken from: from http://edcdaac.usgs.gov/aster/ast_l1b.html

EDG Data Set Name: ASTER L1B Registered Radiance at the Sensor

Granule Shortname: AST_L1B

1. Data Set Characteristics

Area: ~ 60 km x 60 km
<i>Image Dimensions:</i>
VNIR: 4200 rows x 4980 columns VNIR (3B): 4600 rows x 4980 columns SWIR: 2100 rows x 2490 columns TIR: 700 rows x 830 columns
<i>File Size:</i>
VNIR (1,2,3N) = 62,748,000 Bytes VNIR (3B) = 22,908,000 Bytes SWIR (4-9) = 31,374,000 Bytes TIR (10-14) = 5,810,000 Bytes Total = 118 Megabytes
<i>Projection: Universal Transverse Mercator (UTM)</i>
<i>Data Format: HDF-EOS</i>
<i>Vgroup Data Fields: 15</i>

2. Product Description

The ASTER L1B Registered Radiance at the Sensor product contains radiometrically calibrated and geometrically co-registered data for all the channels acquired previously through the telemetry streams of the 3 different telescopes in Level-1A. This product is created by applying the radiometric calibration and geometric correction coefficients to the Level-1A data. Both intra-telescope and inter-telescope registration correction for all the bands has been accomplished relative to the reference band of each sub-system. The Level-1B radiance product offers the same number of bands at the same resolution as the Level-1A product. Level-1B data provide the input for generating higher Level-2 geophysical products. These Level-1B data are produced at the Ground Data System (GDS) in Tokyo, Japan, and sent to the Land Processes (LP) Distributed Active Archive Center (DAAC) for archiving, distribution, and further processing.

Vgroup Data Fields/ Spectral Range (µm)	Units	Data Type	Valid Range	Telescope Pointing Capability
VNIR (15 Meters)				
Band 1 (0.52 - 0.60)	w/m ² /sr/microns	8-bit unsigned integer	0 - 255	+/- 24°
Band 2 (0.63 - 0.69)	w/m ² /sr/microns	8-bit unsigned integer	0 - 255	+/- 24°
Band 3N (0.78 - 0.86)	w/m ² /sr/microns	8-bit unsigned integer	0 - 255	+/- 24°
Band 3B (0.78 - 0.86)	w/m ² /sr/microns	8-bit unsigned integer	0 - 255	+/- 24°
SWIR (30 Meters)				
Band 4 (1.600 - 1.700)	w/m ² /sr/microns	8-bit unsigned integer	0 - 255	+/- 8.55°
Band 5 (2.145 - 2.185)	w/m ² /sr/microns	8-bit unsigned integer	0 - 255	+/- 8.55°
Band 6 (2.185 - 2.225)	w/m ² /sr/microns	8-bit unsigned integer	0 - 255	+/- 8.55°
Band 7 (2.235 - 2.285)	w/m ² /sr/microns	8-bit unsigned integer	0 - 255	+/- 8.55°
Band 8 (2.295 - 2.365)	w/m ² /sr/microns	8-bit unsigned integer	0 - 255	+/- 8.55°
Band 9 (2.360 - 2.430)	w/m ² /sr/microns	8-bit unsigned integer	0 - 255	+/- 8.55°
TIR (90 Meters)				
Band 10 (8.125 - 8.475)	w/m ² /sr/microns	16-bit unsigned integer	0 - 65535	+/- 8.55°
Band 11 (8.475 - 8.825))	w/m ² /sr/microns	16-bit unsigned integer	0 - 65535	+/- 8.55°
Band 12 (8.925 - 9.275)	w/m ² /sr/microns	16-bit unsigned integer	0 - 65535	+/- 8.55°
Band 13 (10.25 - 10.95)	w/m ² /sr/microns	16-bit unsigned integer	0 - 65535	+/- 8.55°
Band 14 (10.95 - 11.65)	w/m ² /sr/microns	16-bit unsigned integer	0 - 65535	+/- 8.55°

3. Product Information

- ASTER Level-1 Data Products Specifications Document
- Algorithm Theoretical Basis Document (ATBD)
- ASTER Standard Data Products Catalog
- ASTER JPL Web Page
- EOS Data Products Handbook Volume 1 (2000)

B. ASTER Radiometric Parameters:

The following is taken from the ASTER User Handbook:

ftp://asterweb.jpl.nasa.gov/outgoing/handbook/ASTER_User_Handbook.doc Chapter 5: Radiometric Parameters

The Level 1B data are in terms of scaled radiance. To convert from DN to radiance at the sensor, the unit conversion coefficients (defined as radiance per 1 DN) are used. Radiance (spectral radiance) is expressed in unit of $W/(m^2 \cdot sr \cdot \mu m)$. The relation between DN values and radiances is shown below:

- a DN value of 0 is allocated to dummy pixels
- a DN value of 1 is allocated to zero radiance
- a DN value of 254 is allocated to the maximum radiance for **VNIR** and **SWIR** bands
- a DN value of 4094 is allocated to the maximum radiance for **TIR** bands
- a DN value of 255 is allocated to saturated pixels for **VNIR** and **SWIR** bands
- a DN value of 4095 is allocated to saturated pixels for **TIR** bands

The maximum radiances depend on both the spectral bands and the gain settings and are shown in Table 1.

Band No.	Maximum radiance ($W/(m^2 \cdot sr \cdot \mu m)$)			
	High gain	Normal Gain	Low Gain 1	Low gain 2
1	170.8	427	569	N/A
2	179.0	358	477	
3N	106.8	218	290	
3B	106.8	218	290	
4	27.5	55.0	73.3	73.3
5	8.8	17.6	23.4	103.5
6	7.9	15.8	21.0	98.7
7	7.55	15.1	20.1	83.8
8	5.27	10.55	14.06	62.0
9	4.02	8.04	10.72	67.0
10	N/A	28.17	N/A	N/A
11		27.75		
12		26.97		
13		23.30		
14		21.38		

Table 1: Maximum radiance values for all ASTER bands and all gains.

The radiance can be obtained from DN values as follows:

$$\text{Radiance} = (\text{DN value} - 1) * \ll \text{Unit conversion coefficient} \gg \quad \text{EQ1}$$

Table 2 shows the unit conversion coefficients of each band:

Band No.	Coefficient (W/(m ² *sr*µm))			
	High gain	Normal Gain	Low Gain 1	Low gain 2
1	0.676	1.688	2.25	N/A
2	0.708	1.415	1.89	
3N	0.423	0.862	1.15	
3B	0.423	0.862	1.15	
4	0.1087	0.2174	0.290	0.290
5	0.0348	0.0696	0.0925	0.409
6	0.0313	0.0625	0.0830	0.390
7	0.0299	0.0597	0.0795	0.332
8	0.0209	0.0417	0.0556	0.245
9	0.0159	0.0318	0.0424	0.265
10	N/A	6.822 x 10 ⁻³	N/A	N/A
11		6.780 x 10 ⁻³		
12		6.590 x 10 ⁻³		
13		5.693 x 10 ⁻³		
14		5.225 x 10 ⁻³		

Table 2: Calculated Unit Conversion Coefficients. The actual Coefficients can be found in the MetaData.

C. The ASTER Calibration File for ATCOR 2.0.x:

The ATCOR2 and 3 Modules employ a sensor specific calibration file to “rescale” the data of the input (“raw”) image to true radiance at sensor which is needed for the correction process. The calibration file reflects all conversions and/or scaling operations which have been done (in most cases to scale the data into an 8- or 16-bit range) by the data supplier prior to delivery.

1. Facts to consider for ASTER L1B data:

- As shown above, the ASTER L1B data are **scaled “radiances at sensor” values**. The scaling factor for each band_[x] is the “conversion coefficient (*incl_[x]*)” as explained above. An offset (bias) of -1 is also used for the scaling.
- The unit in which the ASTER L1B data come are in (W/(m²*sr*µm)) while ATCOR uses (mW/(cm²*sr*µm)) which is factor of 10 smaller.

2. Four Steps to get Radiances at Sensor:

- **Step a:** Import the ASTER L1B Data-File using the ASTER Importer of ERDAS IMAGINE (do not use the "Conversion to Radiance". This outputs an 32-bit floating point file which ATCOR can not handle).
- **Step b:** Find out in which Gain State the ASTER data have been recorded (High gain, Normal Gain, Low Gain 1 or Low gain 2). This can be found after importing in an ERDAS.IMG file via the Tools|View HFA-File Structure| in the HDF Global Attributes or HDF Band Attributes.
- **Step c:** Search for the conversion coefficients (called: $INCL_{[x]}$ for each $Band_{[x]}$): They can also be found in the HDF Global Attributes or HDF Band Attributes. In most cases the values of Table 2 can be used.
- **Step d:** Generate a new calibration file for your ASTER scene using the band conversion coefficients and accounting for the different units employed as described above.

→ To do this the c1 (gain) must be set employing the following formula.

The c0 (offset) value is set to -0.1 (accounting for the different unit[see above]):

$$c1 = incl_{[x]} * 10^{-1}$$

EQ2

- **Example Calibration-File:**

9	c0	c1	[mW/cm² sr micron]
1	-0.1	0.0676	
2	-0.1	0.0708	
3	-0.1	0.0862	
4	-0.1	0.02174	
5	-0.1	0.00696	
6	-0.1	0.00625	
7	-0.1	0.00597	
8	-0.1	0.00417	
9	-0.1	0.00318	

Table 3: **Example for an ASTER.cal file** for an ASTER L1B scene with the following parameters:
 Band 1 and 2 = High Gain, all others = Normal Gain, VNIR and SWIR bands only;
 c1 values were taken from Table 2: "Calculated Unit Conversion Coefficients"

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