MODIS Land Products Quality Assurance Tutorial: Part-3

How to interpret and use MODIS QA information in the Land Surface Reflectance product suite

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Introduction

This third part of the MODIS Land Products QA Tutorial provides the knowledge base to interpret and understand the QA information in the MODIS land surface reflectance (LSR) product suite. It contains QA sources specific to the LSR product collection, interpretation examples, and a demonstration of how one of the LDOPE tools helps deconstruct the QA information. As described in **Part-1** of the QA tutorial, file-level metadata broadly summarizes data quality at the file-level, and is only intended to help in the search and discovery process. Users should not solely depend on file-level metadata as they evaluate data for their application needs. **The primary focus of this tutorial is pixel-level metadata** in the MODIS Land Surface Reflectance product suite.

1. Introduction to the Land Surface Reflectance (LSR) product suite

MODIS land surface reflectance provides an estimate of the surface spectral reflectance for each band as measured at ground level in the absence of atmospheric scattering or absorption. A seven-band product derived from the MODIS level-1B land bands 1–7, LSR provides the most basic remotely sensed surface parameter used as a primary input to produce a number of higher-level MODIS land surface geophysical products. They include Vegetation Indices, Leaf Area Index and Fraction of Photosynthetically Active Radiation, Bidirectional Reflectance Distribution Function and Albedo, Thermal Anomalies, Burned Area, Land Cover, and Snow Cover.

The LSR suite consists of the following ten Terra and Aqua MODIS products:

Platform	Short Name	Product	Spatial Resolution	Temporal Frequency	Raster Type
Terra	MOD09GA	LSR Bands 1–7	500/1000 m	Daily	Tile
Terra	MOD09GQ	LSR Bands 1–2	250 m	Daily	Tile
Terra	MOD09CMG	LSR Bands 1–7	5600 m	Daily	CMG*
Terra	MOD09A1	LSR Bands 1–7	500 m	8-day	Tile
Terra	MOD09Q1	LSR Bands 1–2	250 m	8-day	Tile
Aqua**	MYD09GA	LSR Bands 1–7	500/1000 m	Daily	Tile
Aqua	MYD09GQ	LSR Bands 1–2	250 m	Daily	Tile
Aqua	MYD09CMG	LSR Bands 1–7	5600 m	Daily	CMG*
Aqua	MYD09A1	LSR Bands 1–7	500 m	8-day	Tile
Aqua	MYD09Q1	LSR Bands 1–2	250 m	8-day	Tile

*Climate Modeling Grid

**The Terra-MODIS Land Surface Reflectance product examples in this tutorial apply equally to their Aqua-MODIS incarnations

2. QA sources within the LSR products

The Terra and Aqua versions of the LSR products contain the following QA Science Data Set (SDS) layers:

Short Name	QA Science Datasets
M*D09GQ	250 m Reflectance Band Quality
M*D09Q1	250 m Reflectance Band Quality
M*D09GA	500 m Reflectance Band Quality 1 km Reflectance Data State QA
M*D09A1	500 m Reflectance Band Quality 500 m State Flags
M*D09CMG	Coarse Resolution QA Coarse Resolution State QA

An asterisk refers to both Terra and Aqua versions of the MODIS product

Reflectance Band Quality versus Data State Quality: An important distinction exists between reflectance band QA and data state QA that warrants clarification. The reflectance band QA provides information that qualifies the quality of atmospheric correction at the pixel-level. In contrast, the data state QA provides information about each pixel's state, i.e., those characteristics that are band- or resolution-independent. For instance, each data state QA pixel provides information regarding its state, identity, or contents (and not the quality

of the surface reflectance data) that may comprise land, deep ocean, shallow ocean, clouds, high- or low-aerosol, snow, or fire, etc. State QA SDS layers exist in three Terra and three Aqua MODIS LSR products:

- ⋆ M*D09GA daily 500 m LSR (as 1 km State QA),
- ⋆ M*D09A1 8-day 500 m LSR (as 500 m State QA), and
- ⋆ M*D09CMG daily 0.05° CMG (as Coarse Resolution State QA)

Clarification regarding cloud information source: Some confusion persists regarding the source of cloud information that users should consider as part of their screening process for their particular applications. **Users should tap the State QA SDSs for cloud-specific information.** The reflectance band quality SDSs in the **M*D09GQ** and **M*D09Q1** products carry a parameter called Cloud State that has not been populated since the V3 MODIS collection, and therefore not a reliable source of information. The MODLAND QA bits (discussed in detail in the QA Tutorial: Part-1) are not a viable source of cloud status information for a particular reason: In the case of the LSR products, these bits imply whether a particular pixel was not processed due to cloud effects, but, since the V3 MODIS collection, the algorithm does perform atmospheric correction over clouds. **Given these idiosyncrasies, please ensure that you consult the following State QA SDSs for cloud-specific information in the daily and 8-day products. You can also use this information to extrapolate to apply to the other LSR products with different spatial resolutions:**

1. **state_1km** SDS in the **M*D09GA** daily 500 m LSR products
2. **sur_refl_state_500m** SDS in the **M*D09A1** 8-day 500 m LSR products

The pixel-level cloud-state in these two SDSs is derived from two cloud mask information sources:

1. The MOD35 MODIS Cloud Mask (bits 0-1), and
2. The LSR product generation code-produced internal cloud algorithm (bit 10)

The following sections provide examples delineating how two pixels from each of the different QA SDS layers are parsed and interpreted. This includes how the QA decimal values are converted to binary strings before deconstructing them into bit-words that are uniquely interpreted according to product-specific QA legends. **Users should decide whether the interpreted quality of each pixel is sufficient enough to use in their specific science applications.**

3. Interpretation examples from 250 m daily and 8-day LSR products

Product interpreted: **MOD09GQ** (Terra MODIS Surface Reflectance Daily L2G Global 250 m)
Dataset name: **MOD09GQ.A2006151.h13v09.005.2008115172716.hdf**

MOD09GQ Daily Product: 250 m Reflectance Band Quality interpretation examples

Two pixels are chosen for interpretation from the single 250 m Reflectance Band Quality SDS with the following values:
7633 (Row: 709 and Column: 3358) and
4096 (Row: 888 and Column: 3049)

The first decimal value of **7633** converts to a 16-bit binary value of **0001110111010001**. Depending on your calculator/convertor, you may need to add one or more zeros to the left to complete the 16-bit string. This bit-string, as assigned to the individual bit numbers, breaks down thus (based on the QA index specified in the MOD09GQ product's file specifications, whose URL is provided in the references). You can convert decimal values to binary either using a scientific calculator or via an online conversion tool. A couple of these online tools are cited in the references:

This binary bit-string is parsed from right to left[1], and the individual bits within a bit-word are read from left to right as described in the following table:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Modland QA	01	Corrected product produced at less than ideal quality some or all bands
2–3	Cloud State	00	~~Clear~~ **[Not populated since V3 collection]**
4–7	Band-1 Data Quality	1101	Correction out of bounds, pixel constrained to extreme allowable value
8–11	Band-2 Data Quality	1101	Correction out of bounds, pixel constrained to extreme allowable value
12	Atm. Corr. Performed	1	Yes
13	Adj. Corr. Performed	0	No
14–15	Spare	00	….

[1]All HDF-EOS products are written in the big-endian referencing scheme. The bits are always numbered from right (least-significant bit) to left (most-significant bit).

The second decimal value of **4096**, when converted to binary, breaks down thus:

00 | 0 | 1 | 0000 | 0000 | 00 | 00 … and interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Modland QA	00	Corrected product produced at ideal quality all bands
2–3	Cloud State	00	~~Clear~~ **[Not populated since V3 collection]**
4–7	Band-1 Data Quality	0000	Highest quality
8–11	Band-2 Data Quality	0000	Highest quality
12	Atm. Corr. Performed	1	Yes
13	Adj. Corr. Performed	0	No
14–15	Spare	00	----

Product interpreted: **MOD09Q1** (Terra MODIS Surface Reflectance 8-Day L3 Global 250 m)
Dataset name: **MOD09Q1.A2006153.h13v09.005.2008123095934.hdf**

MOD09Q1 8-Day Product: 250 m Reflectance Band Quality interpretation examples

Two pixels are chosen for interpretation from the single 250 m Reflectance Band Quality SDS with the following values:
7425 (Row: 1107 and Column: 2921) and
4305 (Row: 1000 and Column: 3017)

The decimal value of **7425** breaks down to the following 16-bit binary string:

00 | 0 | 1 | 1101 | 0000 | 00 | 01 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Modland QA	01	Corrected product produced at less than ideal quality some or all bands
2–3	Cloud State	00	~~Clear~~ **[Not populated since V3 collection]**
4–7	Band-1 Data Quality	0000	Highest quality
8–11	Band-2 Data Quality	1101	Correction out of bounds, pixel constrained to extreme allowable value
12	Atm. Corr. Performed	1	Yes
13	Adj. Corr. Performed	0	No
14–15	Spare	00	----

The decimal value of **4305** breaks down to the following 16-bit binary string:

00 | 0 | 1 | 0000 | 1101 | 00 | 01 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Modland QA Bits	01	Corrected product produced at less than ideal quality some or all bands
2–3	Cloud State	00	~~Clear~~ **[Not populated since V3 collection]**
4–7	Band-1 Data Quality	1101	Correction out of bounds, pixel constrained to extreme allowable value
8–11	Band-2 Data Quality	0000	Highest quality
12	Atm. Corr. Performed	1	Yes
13	Adj. Corr. Performed	0	No
14–15	Spare	00	----

4. Interpretation examples from 500 m daily and 8-day LSR products

Product interpreted: **MOD09GA** (Terra MODIS Surface Reflectance Daily L2G Global 500 m)
Dataset name: **MOD09GA.A2006151.h13v09.005.2008115172715.hdf**

The MOD09GA product contains two SDS QA layers, the 500 m Reflectance Band Quality and 1 km Reflectance Data State QA.

MOD09GA Daily Product: 500 m Reflectance Band Quality interpretation examples

Two pixels are chosen for interpretation from the 500 m Reflectance Band Quality SDS with the following values:
2069626883 (Row: 315 and Column: 328) and
1946157057 (Row: 376 and Column: 503)

The decimal value of **2069626883** breaks down to the following 32-bit binary string:

0 | 1 | 1110 | 1101 | 0111 | 0000 | 0000 | 0000 | 0000 | 11 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Modland QA Bits	11	Corrected product not produced for other reasons -- some or all bands may be fill value
2–5	Band-1 Data Quality	0000	Highest quality
6–9	Band-2 Data Quality	0000	Highest quality
10–13	Band-3 Data Quality	0000	Highest quality
14–17	Band-4 Data Quality	0000	Highest quality
18–21	Band-5 Data Quality	0111	Noisy detector
22–25	Band-6 Data Quality	1101	Correction out of bounds, pixel constrained to extreme allowable value
26–29	Band-7 Data Quality	0111	Noisy detector
30	Atm. Corr. Performed	1	Yes
31	Adj. Corr. Performed	0	No

The decimal value of **1946157057** breaks down to the following 32-bit binary string:

0 | 1 | 1101 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 01 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Modland QA Bits	01	Corrected product produced at less than ideal quality -- some or all bands
2–5	Band-1 Data Quality	0000	Highest quality
6–9	Band-2 Data Quality	0000	Highest quality
10–13	Band-3 Data Quality	0000	Highest quality
14–17	Band-4 Data Quality	0000	Highest quality
18–21	Band-5 Data Quality	0000	Highest quality
22–25	Band-6 Data Quality	0000	Highest quality
26–29	Band-7 Data Quality	1101	Correction out of bounds, pixel constrained to extreme allowable value
30	Atm. Corr. Performed	1	Yes
31	Adj. Corr. Performed	0	No

MOD09GA Daily Product: 1 km Reflectance Data State QA interpretation examples

Two pixels are chosen for interpretation from the 1 km Reflectance State QA SDS with the following values:
1034 (Row: 207 and Column: 211) and
136 (Row: 841 and Column: 1134)

The decimal value of **1034** breaks down to the following 16-bit binary string (users need to add 4 zeros on the left to the 12-digit binary string to render a 16-bit string):

0 | 0 | 0 | 0 | 0 | 1 | 00 | 00 | 001 | 0 | 10 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Cloud State	10	Mixed
2	Cloud Shadow	0	No
3–5	Land/Water Flag	001	Land
6–7	Aerosol Quantity	00	Climatology
8–9	Cirrus Detected	00	None
10	Internal Cloud Algorithm Flag	1	Cloud
11	Internal Fire Algorithm Flag	0	No fire
12	MOD35 Snow/Ice Flag	0	No
13	Pixel is adjacent to cloud	0	No
14	BRDF Correction Performed	0	No
15	Internal Snow Mask	0	No snow

The decimal value of **136** breaks down to the following 16-bit binary string (users need to add 8 zeros on the left to the 12-digit binary string to render a 16-bit string):

0 | 0 | 0 | 0 | 0 | 0 | 00 | 10 | 001 | 0 | 00 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Cloud State	00	Clear
2	Cloud Shadow	0	No
3–5	Land/Water Flag	001	Land
6–7	Aerosol Quantity	10	Average
8–9	Cirrus Detected	00	None
10	Internal Cloud Algorithm Flag	0	No cloud
11	Internal Fire Algorithm Flag	0	No fire
12	MOD35 Snow/Ice Flag	0	No
13	Pixel is adjacent to cloud	0	No
14	BRDF Correction Performed	0	No
15	Internal Snow Mask	0	No snow

Product interpreted: **MOD09A1** (Terra MODIS Surface Reflectance 8-Day L3 Global 500 m)
Dataset name: **MOD09A1.A2006153.h13v09.005.2008123095933.hdf**

The MOD09A1 product contains two SDS QA layers, the 500 m Reflectance Band Quality and 500 m State Flags.

MOD09A1 8-Day Product: 500 m Reflectance Band Quality interpretation examples

Two pixels are chosen for interpretation from the 500 m Reflectance Band Quality SDS with the following values:
1131675649 (Row: 21 and Column: 17) and
2013265923 (Row: 2319 and Column: 2240)

The decimal value of **1131675649** breaks down to the following 32-bit binary string:

0 | 1 | 0000 | 1101 | 1101 | 0000 | 0000 | 0000 | 0000 | 01 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Modland QA Bits	01	Corrected product produced at less than ideal quality -- some or all bands
2–5	Band-1 Data Quality	0000	Highest quality
6–9	Band-2 Data Quality	0000	Highest quality
10–13	Band-3 Data Quality	0000	Highest quality
14–17	Band-4 Data Quality	0000	Highest quality
18–21	Band-5 Data Quality	1101	Correction out of bounds, pixel constrained to extreme allowable value
22–25	Band-6 Data Quality	1101	Correction out of bounds, pixel constrained to extreme allowable value
26–29	Band-7 Data Quality	0000	Highest quality
30	Atm. Corr. Performed	1	Yes
31	Adj. Corr. Performed	0	No

The decimal value of **2013265923** breaks down to the following 32-bit binary string:

0 | 1 | 1110 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 11 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Modland QA Bits	11	Corrected product not produced for other reasons -- some or all bands may be fill value
2–5	Band-1 Data Quality	0000	Highest quality
6–9	Band-2 Data Quality	0000	Highest quality
10–13	Band-3 Data Quality	0000	Highest quality
14–17	Band-4 Data Quality	0000	Highest quality
18–21	Band-5 Data Quality	0000	Highest quality
22–25	Band-6 Data Quality	0000	Highest quality
26–29	Band-7 Data Quality	1110	L1B data faulty
30	Atm. Corr. Performed	1	Yes
31	Adj. Corr. Performed	0	No

MOD09A1 8-Day Product: 500 m State Flags interpretation examples

Two pixels are chosen for interpretation from the 500 m State Flags SDS with the following values:
8204 (Row: 447 and Column: 887) and
1337 (Row: 97 and Column: 233)

The decimal value of **8204** breaks down to the following 16-bit binary string:

0 | 0 | 1 | 0 | 0 | 0 | 00 | 00 | 001 | 1 | 00 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Cloud State	00	Clear
2	Cloud Shadow	1	Yes
3–5	Land/Water Flag	001	Land
6–7	Aerosol Quantity	00	Climatology
8–9	Cirrus Detected	00	None
10	Internal Cloud Algorithm Flag	0	No cloud
11	Internal Fire Algorithm Flag	0	No fire
12	MOD35 Snow/Ice Flag	0	No
13	Pixel is adjacent to cloud	1	Yes
14	BRDF Correction Performed	0	No
15	Internal Snow Mask	0	No snow

The decimal value of **1337** breaks down to the following 16-bit binary string:

0 | 0 | 0 | 0 | 0 | 1 | 01 | 00 | 111 | 0 | 01 which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Cloud State	01	Cloudy
2	Cloud Shadow	0	No
3–5	Land/Water Flag	111	Deep ocean
6–7	Aerosol Quantity	00	Climatology
8–9	Cirrus Detected	01	Small
10	Internal Cloud Algorithm Flag	1	Cloud
11	Internal Fire Algorithm Flag	0	No fire
12	MOD35 Snow/Ice Flag	0	No
13	Pixel is adjacent to cloud	0	No
14	BRDF Correction Performed	0	No
15	Internal Snow Mask	0	No snow

5. Interpretation examples from 5600 m daily CMG LSR products

Product interpreted: **MOD09CMG** (Terra MODIS Surface Reflectance Daily L3 Global CMG)
Dataset name: **MOD09CMG.A2006151.005.2008116224047.hdf**

The MOD09CMG product contains two SDS QA layers, the Coarse Resolution QA and Coarse Resolution State QA.

MOD09CMG Daily Product: Coarse Resolution QA interpretation examples

Two pixels are chosen for interpretation from the Coarse Resolution QA SDS with the following values:
1073741824 (Row: 31 and Column: 13) and
644245095 (Row: 3006 and Column: 7181)

The decimal value of **1073741824** breaks down to the following 32-bit binary string:

0 | 1 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 00 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Modland QA Bits	00	Corrected product produced at ideal quality -- all bands
2–5	Band-1 Data Quality	0000	Highest quality
6–9	Band-2 Data Quality	0000	Highest quality
10–13	Band-3 Data Quality	0000	Highest quality
14–17	Band-4 Data Quality	0000	Highest quality
18–21	Band-5 Data Quality	0000	Highest quality
22–25	Band-6 Data Quality	0000	Highest quality
26–29	Band-7 Data Quality	0000	Highest quality
30	Atm. Corr. Performed	1	Yes
31	Adj. Corr. Performed	0	No

The decimal value of **644245095** breaks down to the following 32-bit binary string:

0 | 0 | 1001 | 1001 | 1001 | 1001 | 1001 | 1001 | 1001 | 11 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Modland QA Bits	11	Corrected product not produced for other reasons -- some or all bands, may be fill value
2–5	Band-1 Data Quality	1001	Solar Zenith >= 86 degrees
6–9	Band-2 Data Quality	1001	Solar Zenith >= 86 degrees
10–13	Band-3 Data Quality	1001	Solar Zenith >= 86 degrees
14–17	Band-4 Data Quality	1001	Solar Zenith >= 86 degrees
18–21	Band-5 Data Quality	1001	Solar Zenith >= 86 degrees
22–25	Band-6 Data Quality	1001	Solar Zenith >= 86 degrees
26–29	Band-7 Data Quality	1001	Solar Zenith >= 86 degrees
30	Atm. Corr. Performed	0	No
31	Adj. Corr. Performed	0	No

MOD09CMG Daily Product: Coarse Resolution State QA interpretation examples

Two pixels are chosen for interpretation from the Coarse Resolution State QA SDS with the following values:
36872 (Row: 593 and Column: 1586) and
9277 (Row: 2446 and Column: 2614)

The decimal value of **36872** breaks down to the following 16-bit binary string:

1 | 0 | 0 | 1 | 0 | 0 | 00 | 00 | 001 | 0 | 00 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Cloud State	00	Clear
2	Cloud Shadow	0	No
3–5	Land/Water Flag	001	Land
6–7	Aerosol Quantity	00	Climatology
8–9	Cirrus Detected	00	None
10	Internal Cloud Algorithm Flag	0	No cloud
11	Internal Fire Algorithm Flag	0	No fire
12	MOD35 Snow/Ice Flag	1	Yes
13	Pixel is adjacent to cloud	0	No
14	BRDF Correction Performed	0	No
15	Internal Snow Mask	1	Snow

The decimal value of **9277** breaks down to the following 16-bit binary string:

0 | 0 | 1 | 0 | 0 | 1 | 00 | 00 | 111 | 1 | 01 … which is interpreted as follows:

Bit-No.	Parameter	Bit-Word	Interpretation
0–1	Cloud State	01	Cloudy
2	Cloud Shadow	1	Yes
3–5	Land/Water Flag	111	Deep ocean
6–7	Aerosol Quantity	00	Climatology
8–9	Cirrus Detected	00	None
10	Internal Cloud Algorithm Flag	1	Cloud
11	Internal Fire Algorithm Flag	0	No fire
12	MOD35 Snow/Ice Flag	0	No
13	Pixel is adjacent to cloud	1	Yes
14	BRDF Correction Performed	0	No
15	Internal Snow Mask	0	No snow

6. Demonstration examples with LDOPE's unpack_sds_bits utility

The Land Data Operational Product Evaluation (LDOPE) group's unpack_sds_bits utility is a tool used to unpack the specific MODIS HDF SDS layers that help translate the binary encoded values for easy interpretation. The values in the output HDF files are either unsigned 8-bit, unsigned 16-bit, or unsigned 32-bit integers. What follows is the syntax for the utility, brief argument details, and two examples from the 250 m and 500 m daily LSR products demonstrating how to use this utility. Further details regarding this utility are available in the LDOPE Tools User Manual cited in the references section.

Syntax: unpack_sds_bits -of = <output filename> [-sds = <SDSname1>[<,SDSname2>...] -bit = <Bitnumbers> -meta filename

Arguments:		
	unpack_sds_bits	Name of the executable
	-of = <output filename>	Output filename
	-sds = <SDS list>	List of SDSs to process. SDS names are separated by commas with no space
	-bit = <Bitnumbers>	List of bit numbers separated by commas. A range of bit numbers may be specified using '-' between the starting and ending bit numbers, e.g., -bit = 4-8
	-meta	Copy metadata from input file to output file
	filename	Input filename

MOD09GQ Daily Product: 250 m Reflectance Band Quality example

Executing the utility with the -help flag against the input filename provides specific details regarding relevant input SDS layer names:

unpack_sds_bits -help MOD09GQ.A2006151.h13v09.005.2008115172716.hdf

unpack_sds_bits -of = mod09gq_2006151_h13v09_250m-QA.hdf -sds = "250 m Reflectance Band Quality – first layer" -bn = 0-1, 2-3, 4-7, 8-11, 12, 13, 14-15 MOD09GQ.A2006151.h13v09.005.2008115172716.hdf

The above execution will output an HDF file that contains following SDS layers with parsed integer values for each existing bit combination between 0 and 15 for the chosen QA SDS:

QC_250m_1_bits_0-1	[Modland QA Bits]
QC_250m_1_bits_2-3	[Cloud State]
QC_250m_1_bits_4-7	[Band-1 Data Quality]
QC_250m_1_bits_8-11	[Band-2 Data Quality]
QC_250m_1_bits_12	[Atmospheric Correction Performed]
QC_250m_1_bits_13	[Adjacency Correction Performed]
QC_250m_1_bits_14-15	[Spare … Unused]

Users may open, browse, and query any of these output layers in any of the proprietary as well as public domain image processing software tools that handle HDF.

MOD09GA Daily Product: 500 m Reflectance Band Quality interpretation example

unpack_sds_bits -of = mod09ga_2006151_h13v09_500m-QA.hdf -sds = "500 m Reflectance Band Quality" -bit = 0-1, 2-5, 6-9, 10-13, 14-17, 18-21, 22-25, 26-29, 30, 31 MOD09GA.A2006151.h13v09.005.2008115172715.hdf

The above execution will output an HDF file that contains following SDS layers with parsed integer values for each existing bit combination between 0 and 31 for the chosen QA SDS:

QC_500m_1_bits_0-1	[Modland QA Bits]
QC_500m_1_bits_2-5	[Band-1 Data Quality]
QC_500m_1_bits_6-9	[Band-2 Data Quality]
QC_500m_1_bits_10-13	[Band-3 Data Quality]
QC_500m_1_bits_14-17	[Band-4 Data Quality]
QC_500m_1_bits_18-21	[Band-5 Data Quality]
QC_500m_1_bits_22-25	[Band-6 Data Quality]
QC_500m_1_bits_26-29	[Band-7 Data Quality]
QC_500m_1_bits_30	[Atmospheric Correction Performed]
QC_500m_1_bits_31	[Adjacency Correction Performed]

Users may open, browse, and query any of these output layers in any of the proprietary as well as public domain image processing software tools that handle HDF.

cp_proj_param utility

The **cp_proj_param** is another LDOPE tool that helps create an output HDF-EOS file by copying all the SDS layers from the input HDF file along with its projection parameters and geolocation bounding coordinates to the output file. Following this transfer of information, the output file is ready for re-projection and other data transformation activities. Users may find **cp_proj_param** useful to apply to the parsed QA files produced through **unpack_sds_bits** utility.

Syntax: cp_proj_param -help
cp_proj_param -of = <output filename> [-ref=<reference>] [-tile = <tile_id(s)>]
[-proj = <projection type>] filename

Example-1: cp_proj_param -ref = MOD09GQ.A2006151.h13v09.005.2008115172716.hdf
-of = mod09gq_250m_QA_Coords.hdf
mod09gq_2006151_h13v09_250m-QA.hdf

Example-2: cp_proj_param -ref = MOD09GA.A2006151.h13v09.005.2008115172715.hdf
-of = mod09ga_500m_QA_Coords.hdf
mod09ga_2006151_h13v09_500m-QA.hdf

References

NASA LP DAAC (March 1, 2012) MODIS Land Products Quality Assurance Tutorial: Part-1. How to find, understand, and use the quality assurance information for MODIS land products. Available from: https://lpdaac.usgs.gov/media/files/one_pager_files/modis_land_products_quality_assurance_tutorial_part_1

Vermote, E. F., Kotchenova, S. Y., and Ray, J. P. (2011) MODIS Surface Reflectance User's Guide (Version 1.3). Available from: http://modis-sr.ltdri.org

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