

MODIS Level-1 Science Processing Algorithm (MODISL1DB_SPA) User's Guide

Version 1.8

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**GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND**

MODIS Level-1 Science Processing Algorithm

MODISL1DB_SPA

General

The NASA Goddard Space Flight Center's (GSFC) Direct Readout Laboratory (DRL), Code 606.3 developed this software for the International Polar Orbiter Processing Package (IPOPP). The IPOPP package maximizes the utility of Earth science data for making real-time decisions by giving fast access to instrument data and derivative products from the Suomi National Polar-orbiting Partnership (NPP), Aqua, and Terra missions and, in the future, the Joint Polar Satellite System (JPSS) mission.

Users must agree to all terms and conditions in the Software Usage Agreement on the DRL Web Portal before downloading this software.

Software and documentation published on the DRL Web Portal may occasionally be updated or modified. The most current versions of DRL software are available at the DRL Web Portal:

<http://directreadout.sci.gsfc.nasa.gov/?id=software>

Questions relating to the contents or status of this software and its documentation should be addressed to the DRL via the Contact DRL mechanism at the DRL Web Portal:

<http://directreadout.sci.gsfc.nasa.gov/?id=dspContent&cid=66>

Algorithm Wrapper Concept

The DRL has developed an algorithm wrapper to provide a common command and execution interface to encapsulate multi-discipline, multi-mission science processing algorithms. The wrapper also provides a structured, standardized technique for packaging new or updated algorithms with minimal effort.

A Science Processing Algorithm (SPA) is defined as a wrapper and its contained algorithm. SPAs will function in a standalone, cross-platform environment to serve the needs of the broad Direct Readout community. Detailed information about SPAs and other DRL technologies is available at the DRL Web Portal.

Software Description

This software package contains the MODIS Level 1 Direct Broadcast SPA (MODISL1DB_SPA). It processes Level 0 MODIS data into Level 1A (MOD01/MYD01) and Geolocation (MOD03/MYD03) products. It also processes Level 1A and Geolocation products into MODIS Level 1B 1km (MOD021KM/MYD021KM), half km (MOD02HKM/MYD02QKM), and quarter km (MOD02QKM/MYD02QKM) granules. The MODISL1DB_SPA functions in two modes: Standalone, or as an IPOPP plug-in.

Software Version

Version 1.1 of the DRL algorithm wrapper was used to package the SPA described in this document. This package contains the MODIS Level 1 Direct Broadcast software (MODISL1DB 1.8, June 4, 2012).

Enhancements to Version 1.8 of the MODISL1DB_SPA include an update to MODIS Terra and Aqua L1B processing. The MODIS Calibration Support Team (MCST) modified the Look-Up Table (LUT) format and made corresponding code modifications to the MODISL1DB core algorithm.

This software will execute on a 64-bit computer, and has been tested with the following operating systems:

- a) Fedora 14 X86_64;
- b) CentOS Linux 6.2 X86_64;
- c) OpenSUSE Linux 11.4 X86_64;
- d) Kubuntu 11.04 X86_64.

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Credits

The algorithm was enhanced by the Ocean Biology Processing Group (OBPG) at NASA/GSFC; the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin; and the DRL at NASA/GSFC.

Prerequisites

To run this package, you must have the Java Development Kit (JDK) or Java Runtime Engine (JRE) (Java 1.6.0_25 or higher) installed on your computer, and the bin directory of your Java installation in your PATH environment variable. The internal C Shell processing scripts in MODISL1DB_SPA Version 1.8 have been replaced with Python scripts, so you must also have Python 2.7 installed on your computer. If you need to upgrade Python, go to: <http://www.python.org/download/releases>.

Program Inputs and Outputs

See the Program Operation subsection.

Installation and Configuration

This section contains instructions for installing an SPA in a standalone configuration. SPAs may also be installed dynamically into an IPOPP framework; instructions for this type of installation are contained in the IPOPP User's Guide.

Download the MODISL1DB_1.8_SPA_1.1.tar.gz and MODISL1DB_1.8_SPA_1.1_testdata.tar.gz (optional) files into the same directory.

Decompress and un-archive the MODISL1DB_1.8_SPA_1.1.tar.gz and MODISL1DB_1.8_SPA_1.1_testdata.tar.gz (optional) files:

```
$ tar -xzf MODISL1DB_1.8_SPA_1.1.tar.gz
```

```
$ tar -xzf MODISL1DB_1.8_SPA_1.1_testdata.tar.gz
```

This will create the following subdirectories:

SPA

modisl1db

algorithm

ancillary

station

wrapper

testscripts

testdata

Software Package Testing and Validation

The testscripts subdirectory contains test scripts that can be used to verify that your current installation of the SPA is working properly, as described below. Note that the optional MODISL1DB_1.8_SPA_1.1_testdata.tar.gz file is required to execute these testing procedures.

Step 1: cd into the testscripts directory.

Step 2: Run the 'run-l0tol1_terra' script by typing:

```
$/run-l0tol1_terra
```

A successful execution usually takes about 1 minute, depending on the speed of your computer. If everything is working properly, the script will terminate with a message such as:

```
Output modis.mxd01 is /home/IPOPP/SPA/modisl1db/testdata/output/L1ATerra.hdf
```

```
Output modis.mxd03 is /home/IPOPP/SPA/modisl1db/testdata/output/GEOTerra.hdf
```

The preceding script runs the Level 0 to Level 1A process. It uses the Terra MODIS Level 0 input file to produce MODIS Level 1A and Geolocation products. You can cd to the output directory to verify that the science products exist. If there is a problem and the code terminates abnormally, the problem can be identified using the log files. Log files are generated automatically within the directory used for execution. They start with stdfile* and errfile*. Please report any errors that cannot be fixed to the DRL.

To test the Level 0 to Level 1A process for Aqua MODIS, run the 'run-l0tol1_aqua' script by typing:

```
$/run-l0tol1_aqua
```

To test the Level 1A to Level 1B process for Terra MODIS, run the 'run-l1atob_terra' script by typing:

```
./run-l1atob_terra
```

If everything is working properly, the script will terminate with a message such as:

```
Output modis.mxd021km is  
/home/IPOPP/SPA/modisl1db/testdata/output/L1B1KMTerra.hdf
```

```
Output modis.mxd02hkm is  
/home/IPOPP/SPA/modisl1db/testdata/output/L1BHKMTerra.hdf
```

```
Output modis.mxd02qkm is  
/home/IPOPP/SPA/modisl1db/testdata/output/L1BQKMTerra.hdf
```

Verify that the output products exist in the output directory. Report any unusual behavior to the DRL.

To test the Level 1A to Level 1B process for Aqua MODIS, run the 'run-l1atob_aqua' script by typing:

```
./run-l1atob_aqua
```

Test output product(s) are available for comparison in the testdata/output directory. These test output product(s) were generated on a 64-bit PC architecture computer running Fedora 14. The output products serve as an indicator of expected program output. Use a comparison utility (such as diff, hdiff, etc.) to compare your output product(s) to those provided in the testdata/output directory. Locally generated files may differ slightly from the provided output files because of differences in machine architecture or operating systems.

Program Operation

In order to run the package using your own input data, you can either use the run scripts within the wrapper directory, or modify the test script within the testscripts directory.

To Use the Run Scripts

Identify the 'run' scripts: The wrapper directory within this package contains two subdirectories, one for each of the two processes, i.e., Level 0 to Level 1A and Level 1A to Level 1B. Each subdirectory contains an executable called 'run'. You must execute the 'run' within the correct wrapper subdirectory to execute the corresponding process. For instance the 'run' within the wrapper/l0to1 directory is for creating the MODIS Level 1A and Geolocation products, while the 'run' within the wrapper/l1atob directory should be used for creating MODIS Level 1B products. Note that to execute 'run', you need to have java on your path.

Specify input parameters using <label value> pairs: To execute the 'run' scripts, you must supply the required input and output parameters. Input and output parameters are usually file paths or other values (e.g., the satellite name). Each parameter is specified on the command line by a <label value> pair. Labels are simply predefined names for parameters. Each label must be followed by its actual

value. Each process has its own set of <label value> pairs that must be specified in order for it to execute. Some of these pairs are optional, meaning the process would still be able to execute even if that parameter is not supplied. There are three types of <label value> pairs that the MODIS Level 1 SPA uses, as follows:

- a) Input file label/values. These are input file paths. Values are absolute or relative paths to the corresponding input file.
- b) Parameter label/values. These are parameters that need to be passed onto the SPA (e.g., the name of the platform).
- c) Output file labels. These are output files that are produced by the SPA. Values are the relative/absolute paths of the files you want to generate.

The following table contains labels, and their descriptions, required by the MODIS Level 0 to Level 1A wrapper.

Input File Labels	Description	Source
modis.pds	MODIS Level 0 PDS file	<p>DRL Web Portal for recent data over the eastern US:</p> <p>Terra MODIS Level 0: ftp://is.sci.gsfc.nasa.gov/gsfcdata/terra/modis/level0</p> <p>Aqua MODIS Level 0: ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/modis/level0</p> <p>Datasets from your Direct Readout station</p>
gbad_eph (optional)	Near-real time ephemeris data files for Aqua	<p>For ephemeris and attitude files corresponding to recent Aqua Direct Broadcast granules over the eastern US:</p> <p>ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/gbad</p>
gbad_att (optional)	Near-real time attitude data files for Aqua	<p>For all other Aqua passes ephemeris and attitude files should be generated from Aqua Level 0 files using GBAD_SPA, available for download at:</p> <p>http://directreadout.sci.gsfc.nasa.gov/?id=software</p>
leapsec (optional)	Leap second file	<p>For recent LEAPSEC files:</p> <p>ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/</p>
utcpole (optional)	Earth motion file	<p>For recent UTCPOLE files:</p> <p>ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/</p>
Parameter Labels	Description	
sat	Platform – 'TERRA' or 'AQUA'	
geocheck_threshold (optional)	<p>The percentage of geo-populated pixels required to pass the geocheck validation test. The geocheck validation test calculates the percentage of pixels that were not successfully geolocated, and if this percentage is less than the geocheck_threshold, the processing will assume failure and will not delete temporary processing and log files (default value = 95). In IPOPP mode, this geocheck_threshold has been preset to 50.</p>	

Output File Labels	Description
modis.mxd01	MODIS Level 1A HDF file (MOD01/MYD01)
modis.mxd03	MODIS Geolocation HDF file (MOD03, MYD03)

Notes on file inputs:

1. Attitude and ephemeris inputs are not needed for Terra Level 0 processing. The SPA will either automatically download the most recent set of ephemeris and attitude files from the OBPG ancillary site or (when they are not available) use the near-real time attitude and ephemeris embedded in Terra Level 0 or Level 1A files. For Aqua Level 0 processing, users have the option of providing Aqua ephemeris and attitude files via the gbad_eph and gbad_att labels. Aqua Ephemeris and attitude files should be generated from Aqua Level 0 files using GBAD_SPA, available for download at: <http://directreadout.sci.gsfc.nasa.gov/?id=software>. However, if you do not provide these inputs for MODIS Aqua, the SPA will automatically download the most recent set of ephemeris and attitude files from the OBPG ancillary site. Since the SPA may need to download the ephemeris and attitude files, make sure you have an Internet connection.
2. The leapsec and utcpole inputs are also optional. They are downloaded automatically if they are not provided on the command line. If you do not wish to provide your own inputs, you need to have an Internet connection to download the required files automatically during execution. However, if you use your own inputs for these two files, it is recommended to use leapsec and utcpole input files that are not more than 14 days old.

The following table contains labels, and their descriptions, required by the MODIS Level 1A to Level 1B wrapper.

Input File Labels	Description	Source
modis.mxd01	MODIS Level 1A HDF file (MOD01/MYD01)	DRL ftp site for recent data over eastern US:
modis.mxd03	MODIS Geolocation HDF file (MOD03, MYD03)	<p>Terra MODIS Level 1 and Geolocation: ftp://is.sci.gsfc.nasa.gov/gsfcddata/terra/modis/level1</p> <p>Aqua MODIS Level 1 and Geolocation: ftp://is.sci.gsfc.nasa.gov/gsfcddata/aqua/modis/level1</p> <p>Datasets from your Direct Readout station</p>
modis_reflective_luts	Reflective Look-up Table (LUT)	LUTs for Terra MODIS: ftp://is.sci.gsfc.nasa.gov/ancillary/LUTs/terra/modis
modis_emissive_luts	Emissive LUT	
modis_qa_luts	QA LUT	LUTs for Aqua MODIS: ftp://is.sci.gsfc.nasa.gov/ancillary/LUTs/aqua/modis

Output File Labels	Description
modis.mxd021km	MODIS 1km L1B Calibrated Geolocated Radiances HDF file (MOD021KM, MYD021KM)
modis.mxd02hkm	MODIS 500m L1B Calibrated Geolocated Radiances HDF file (MOD02HKM, MYD02HKM)
modis.mxd02qkm	MODIS 250m L1B Calibrated Geolocated Radiances HDF file (MOD02QKM, MYD02QKM)

Notes:

1. The LUTs change frequently. Users running the SPA in standalone mode should regularly check for updated LUTs on the DRL ftp site (See Table above for locations). The most recent set of LUTs at the time of release are available in <modis1db_SPA_home>/algorithm/run/var/modisa/cal/OPER (for Aqua) and <modis1db_SPA_home>/algorithm/run/var/modist/cal/OPER (for Terra). In IPOPP mode, the SPA is already pre-configured to fetch and use the latest LUTs.
2. The MODIS 500m and 250m Calibrated Geolocated Radiances are not produced for night time swaths.

Execute the 'runs': The following are examples of command lines to run the MODIS Level 0 to Level 1A process and the Level 1A to Level 1B process from the testscripts subdirectory. You can run them from the directory of your choice by using the correct paths to the 'run' scripts and your datasets.

```

$./wrapper/l0to1/run \
modis.pds ../testdata/input/P1540064AAAAAAAAAAAAAAAA12255195533001.PDS \
sat AQUA \
modis.mxd01 ../testdata/output/L1AAqua.hdf \
modis.mxd03 ../testdata/output/GEOAqua.hdf \
gbad_eph ../testdata/input/P1540957AAAAAAAAAAAAAAAA12255195533001.eph \
gbad_att ../testdata/input/P1540957AAAAAAAAAAAAAAAA12255195533001.att

```

Output modis.mxd01 is /home/IPOPP/modisl1db/testdata/output/L1AAqua.hdf

Output modis.mxd03 is /home/IPOPP/modisl1db/testdata/output/GEOAqua.hdf

```

$./wrapper/l1atob/run \
modis.mxd01 ../testdata/input/L1AAqua.hdf \
modis.mxd03 ../testdata/input/GEOAqua.hdf \
modis_reflective_luts ../testdata/input/MYD02_Reflective_LUTs.V6.1.17.1.hdf \
modis_emissive_luts ../testdata/input/MYD02_Emissive_LUTs.V6.1.17.1.hdf \

```

```
modis_qa_luts ../testdata/input/MYD02_QA_LUTs.V6.1.17.1.hdf \  
modis.mxd021km ../testdata/output/L1B1KMAqua.hdf \  
modis.mxd02hkm ../testdata/output/L1BHKMAqua.hdf \  
modis.mxd02qkm ../testdata/output/L1BQKMAqua.hdf
```

Output modis.mxd021km is /home/IPOPP/modisl1db/testdata/output/L1B1KMAqua.hdf

Output modis.mxd02hkm is /home/IPOPP/modisl1db/testdata/output/L1BHKMAqua.hdf

Output modis.mxd02qkm is /home/IPOPP/modisl1db/testdata/output/L1BQKMAqua.hdf

A successful execution usually takes about 2 minutes, depending on the speed of your computer. If execution fails, you will see an error message indicating the cause of failure (e.g., a file cannot be found, or a label cannot be recognized). Correct the problem and run again. The problem can also be identified using the `stdfile*` and `errfile*` log files. Log files are generated automatically within the directory used for execution.

To Use the Script in the testscripts Directory

One simple way to run the algorithms from any directory of your choice, using your own data, is to copy the corresponding `run-xxx` script from the `testscripts` directory to the selected directory. Change the values of the different variables to reflect the file paths of the wrapper directories and the input/output files. Then modify the input/output file name and satellite platform variables. If required add more parameters to the command line. Run the script to process your data.