MODIS Level 2 IMAPP Atmospheric Science Processing Algorithm (IMAPP_SPA) User's Guide

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MODIS Level 2 IMAPP Atmospheric Science Processing Algorithm

IMAPP_SPA

General

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

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:

https://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:

https://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 DRL software package contains the MODIS IMAPP_SPA (International MODIS/AIRS Processing Package SPA). The IMAPP_SPA processes MODIS Aqua and Terra Level 1B data into six Level 2 MODIS atmospheric products: Cloudmask (MOD35); Cloudmask First Byte; Cloudtop Properties, Cloud Phase and Cloud Optical properties (MOD06); Atmospheric Profiles (MOD07); Aerosol (MOD04); and Aerosol 3km (MOD04_3K). The SPA functions in two modes: Standalone, or as an IPOPP plug-in.

Software Version

Version 1.4 of the DRL algorithm wrapper was used to package the SPA described in this document. The IMAPP_SPA has been ported from IMAPP Version 3.1.1 (30th October 2017). This SPA represents MODIS Collection 6.

Enhancements to this SPA include:

a) new Terra destriping coefficients and new Cloud Mask thresholds put into place after the Terra Safe-Hold Event that took place in February 2016;

b) changes to meteorological ancillary requirements.

This software will execute on a 64-bit computer. This software has been tested on a computer with 32GB of RAM and a CentOS 7 Linux X86_64 operating system.

Credits

The IMAPP software package was developed by the IMAPP Team at the Space Science and Engineering Center (SSEC), University of Wisconsin-Madison.

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 have the Java installation bin/ subdirectory in your PATH environment variable.

Program Inputs and Outputs

Inputs to the IMAPP_SPA are as follows:

a) the MODIS 1km, half km, and quarter km L1B Calibrated Geolocated Radiances Hierarchical Data Format (HDF) products;

b) the MODIS Geolocation HDF product;

c) Ancillary files for leapsec, utcpole, ice/snow extent, sea ice concentration, sea surface temperature, ozone, clear sky radiance bias, and meteorology.

The IMAPP_SPA outputs the following atmospheric products:

a) MODIS Cloudmask Level 2 (MOD35);

b) MODIS Cloudmask First Byte Level 2;

c) MODIS Cloudtop Properties, Cloud Phase and Cloud Optical Properties Level 2 (MOD06);

d) MODIS Atmospheric Profiles Level 2 (MOD07);

e) MODIS Aerosol Level 2 (MOD04);

f) MODIS Aerosol 3km Level 2 (MOD04_3K).

Installation and Configuration

NOTE: Due to limited resources, as well as the many variables that impact scientific integrity and algorithm stability, the DRL will soon no longer support the Standalone Mode for SPA processing. We strongly encourage you now to run SPAs in IPOPP Mode exclusively, that is, from within the IPOPP processing framework. IPOPP will autonomously:

- discover and register raw sensor data;
- retrieve ancillaries from the DRL's real-time and archived ancillary repositories;
- register ancillaries in its Ancillary File Cache;
- schedule SPA executions;
- fulfill science data/ancillary requests from SPAs;
- generate science data products; and
- manage the IPOPP file system.

Installing into an IPOPP Framework: This SPA can also be installed dynamically into an IPOPP framework to automate production of MODIS Cloudmask Level 2 (MOD35); MODIS Cloudtop Properties, Cloud Phase and Cloud Optical Properties Level 2 (MOD06); MODIS Atmospheric Profiles Level 2 (MOD07); MODIS Aerosol Level 2 (MOD04); and MODIS 3km Aerosol Level 2 (MOD04_3K) data products. The SPA installation process will install its SPA service(s) into IPOPP. An SPA service is an IPOPP agent that provides the mechanism necessary for running an SPA automatically within the IPOPP framework. Once this SPA is installed, users must enable the SPA service(s) corresponding to this SPA along with any other prerequisite SPA service(s). Instructions for installing an SPA and enabling its services are contained in the IPOPP User's Guide (available on the DRL Web Portal). The SPA services associated with this SPA are listed in Appendix A.

The installation process described in the IPOPP User's Guide will install the main SPA tarball (IMAPP_3.1.1_SPA_1.4.tar.gz).The optional IMAPP_3.1.1_SPA_1.4_MOD06OD_COEFF.tar.gz file will need to be installed with an additional step after the IPOPP SPA installation. Note that installation of this tarball will significantly increase the processing time. If you are not installing the MOD06OD tarball as part of the primary tarball installation, then make sure that the SPA services have been stopped before the installation (refer to IPOPP User's Guide if needed). Put the IMAPP_3.1.1_SPA_1.4_MOD06OD_COEFF.tar.gz file under $HOME/drl on the IPOPP machine and from that directory execute

```
tar -xzf IMAPP_3.1.1_SPA_1.4_MOD06OD_COEFF.tar.gz
```

This will install the optional Cloud Optical Properties coefficient files.

Installing as a Standalone Application:

NOTE: If you have a previous version of this SPA installed, delete the SPA/<SPAname> directory before decompressing and un-archiving the new SPA tar file.

Download the IMAPP_3.1.1_SPA_1.4.tar.gz,
IMAPP_3.1.1_SPA_1.4_MOD06OD_COEFF.tar.gz (optional), and
IMAPP_3.1.1_SPA_1.4_testdata.tar.gz (optional) files into the same directory.

Decompress and un-archive the IMAPP_3.1.1_SPA_1.4.tar.gz,
IMAPP_3.1.1_SPA_1.4_MOD06OD_COEFF.tar.gz and
IMAPP_3.1.1_SPA_1.4_testdata.tar.gz (optional) files:

```
$ tar -xzf IMAPP_3.1.1_SPA_1.4.tar.gz
$ tar -xzf IMAPP_3.1.1_SPA_1.4_MOD06OD_COEFF.tar.gz [Optional]
$ tar -xzf IMAPP_3.1.1_SPA_1.4_testdata.tar.gz
```

This will create the following subdirectories:

- SPA
  - IMAPP
    - algorithm
    - ancillary
    - station
    - testdata
    - testscripts
    - wrapper

NOTE: The IMAPP_3.1.1_SPA_1.4_MOD06OD_COEFF.tar.gz file contains coefficient files required by the MODIS Cloud Optical Properties software module (MOD06OD). This module populates the cloud optical property arrays in the MODIS Cloudtop Properties, Cloud Phase, Cloud Optical Properties (MOD06) output product. In the absence of these coefficient files, the Cloud Optical Properties algorithm will not be run and the corresponding datasets in the MODIS Cloudtop Properties, Cloud Phase, Cloud Optical Properties (MOD06) output product will remain unpopulated. Note that MOD06OD tarball installation requires about 27 GB of space and if enabled, the Cloud Optical Properties processing requires significant amount of time.

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 IMAPP_3.1.1_SPA_1.4_testdata.tar.gz file is required to execute these testing procedures.

Step 1: cd into the testscripts directory.

Step 2: Download the latest leapsec and utcpole files from the locations listed below to your desired location (e.g., testdata/input)

Leapsec: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/leapsec.*yyyymmddhh*[1].dat
Utcpole: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/utcpole.*yyyymmddhh*[1].dat
[1]Where yyyy, mm, dd, hh represents the year, month, day, and hour for the leapsec and utcpole ancillary file.

Step 3: There is a script named run_TERRA_IMAPP.sh inside the testscripts directory. Edit the run_TERRA_IMAPP.sh script to update the LEAPSEC and UTCPOLE variables to point to the leapsec and utcpole files downloaded in Step 2. Now run the run_TERRA_IMAPP.sh testscript.

To run the IMAPP_SPA algorithm, use

```
$ ./run_TERRA_IMAPP.sh
```

A successful execution usually requires about an hour or more (or about 15 minutes if the MOD06OD tarball is not installed), depending on the speed of your computer and the size of the input. If everything is working properly, the scripts will terminate with a message such as:

```
Output modis.cloudmask is /home/ipopp/drl/SPA/IMAPP/testdata/output/mod35.100601525.hdf
Output modis.cloudmaskbyte is /home/ipopp/drl/SPA/IMAPP/testdata/output/mask_byte1.100601525.hdf
Output modis.cloudtop is /home/ipopp/drl/SPA/IMAPP/testdata/output/mod06.100601525.hdf
Output modis.aerosols is /home/ipopp/drl/SPA/IMAPP/testdata/output/mod04.100601525.hdf
Output modis.aerosols3km is /home/ipopp/drl/SPA/IMAPP/testdata/output/mod04_3k.100601525.hdf
Output modis.atmprofile is /home/ipopp/drl/SPA/IMAPP/testdata/output/mod07.100601525.hdf
```

You can cd to the output directory to verify that the science products exist. 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 CentOS 7. The output products serve as an indicator of expected program output. Use a comparison utility (such as diff, h5diff, 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.

NOTE: Datasets produced by the MODIS Cloud Optical Properties software module (MOD06OD) would remain unpopulated in the MODIS Cloudtop Properties, Cloud Phase, Cloud Optical Properties (MOD06) product if the IMAPP_3.1.1_SPA_1.4_MOD06OD_COEFF.tar.gz is not installed. In that case the MODIS Cloudtop Properties, Cloud Phase, Cloud Optical Properties (MOD06) output product generated by the testscript would differ from the corresponding test output product.

If there is a problem and the code terminates abnormally, the problem can be identified using the log files. Log files are automatically generated within the directory used for execution. They start with stdfile* and errfile*. Other log and intermediate files may be generated automatically within the directory used for execution. They are useful for traceability and debugging purposes. However it is strongly recommended that users clean up log files and intermediate files left behind in the run directory before initiating a fresh execution of the SPA. Intermediate files from a previous run may affect a successive run and produce ambiguous results. Please report any errors that cannot be fixed to the DRL.

Program Operation

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

To Use the Run Scripts

Identify the 'run' scripts: The wrapper directory within this package contains one subdirectory named IMAPP. The subdirectory contains an executable called 'run'. Execute the 'run' to execute the IMAPP_SPA and create MODIS atmospheric 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' script, you must supply the required input and output parameters. Input and output parameters are usually file paths or other values (e.g., an automatic search flag). 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. The three types of <label value> pairs that the IMAPP_SPA uses are:

a) Input file label/values. These are input file paths. Values are absolute or relative paths to the corresponding input file.

b) Output file label/values. These are output files that are produced by the SPA. Values are absolute or relative paths of the files you want to generate.

c) Parameter label/values. These are parameters that need to be passed into the SPA (e.g., platform name or scan time).

The following tables contain labels, and their descriptions, required by the IMAPP_SPA.

Input File Labels	Description	Source
modis.mxd021km	MODIS 1km L1B Calibrated Geolocated Radiances HDF file (MOD021KM, MYD021KM)	1. The MODISL1DB_SPA can be used to create Aqua/Terra MODIS Level 1B products. 2. Real time Aqua/Terra MODIS Level 1B products over the eastern US region are available from the DRL ftp site at: ftp://is.sci.gsfc.nasa.gov/gsfcdata/terra/modis/MOD<021KM | 02HKM | 02QKM | 03>.yyDDDhhmmss.hdf (for Terra) and ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/modis/MYD<021KM | 02HKM | 02QKM | 03>.yyDDDhhmmss.hdf (for Aqua) Where yy, DDD, hh, mm, ss
modis.mxd02hkm (optional- may not be available for night swaths)	MODIS 500m L1B Calibrated Geolocated Radiances HDF file (MOD02HKM, MYD02HKM)	
modis.mxd02qkm (optional - may not be available for night swaths)	MODIS 250m L1B Calibrated Geolocated Radiances HDF file (MOD02QKM, MYD02QKM)	
modis.mxd03	MODIS Geolocation hdf file (MOD03, MYD03)	

Input File Labels	Description	Source
		represents the year, day of year, hour, minute, second for the start of the swath. 3. Aqua/Terra MODIS Level 1B products for other locations and times are available for download at http://reverb.echo.nasa.gov/reverb/
leapsec (required for all products)	Leapsec ancillary file	DRL ftp site for leapsec files: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/leapsec.yyyymmddhh Where yyyy, mm, dd, hh represents the year, month, day, and hour for the leapsec ancillary file.
utcpole (required for all products)	Utcpole ancillary file	DRL ftp site for leapsec files: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/utcpole.yyyymmddhh Where yyyy, mm, dd, hh represents the year, month, day, and hour for the utcpole ancillary file.
ncep_met_1 (required for all products)	NCEP Numerical Weather Prediction GRIdded Binary (GRIB) File. This can be either a Global Data Assimilation System (GDAS1, 6 hourly, 1 degree global) analysis field file or a Global Model Forecast Fields (GFS) file. The SPA requires GDAS and GFS files in grib1 format.	Current GDAS Data: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/global/gdas/gdas1.PGrbF00.yymmdd.hhz Current GFS Data: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/global/gfs/gfs.thh.yymmdd.pgrbfxx Archived GDAS Data: ftp://is.sci.gsfc.nasa.gov/ArchivedAncillary/temporal/global/gdas/gdas1.PGrbF00.yymmdd.hhz where yy, mm, dd, hh and xx represent the 2-digit year, month, date, analysis hour, and forecast time step respectively
ncep_met_1_prev (at least one of ncep_met_1_prev or ncep_met_1_next is required)		
ncep_met_1_next (at least one of ncep_met_1_prev or ncep_met_1_next is required)		
ncep_met_3_before (required for Cloudtop Properties, Cloud Phase, Cloud Optical Properties product)		

Input File Labels	Description	Source
ncep_met_3_after (required for Cloudtop Properties, Cloud Phase, Cloud Optical Properties product)		
ssmi_nise (required for all products)	NSIDC NISE (Near-real time Ice and Snow Extent) (1 degree, global, daily)	Current Data: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/global/nise/NISE_SSMIF13_yyyymmdd.HDFEOS Archived Data: ftp://is.sci.gsfc.nasa.gov/ArchivedAncillary/temporal/global/nise/NISE_SSMIF13_yyyymmdd.HDFEOS where yyyy, mm and dd represent the 4-digit year, month, and date respectively
ssmi_seaice (required for all products)	National Centers for Environmental Prediction (NCEP) sea ice concentration (1 degree, global, daily)	Current Data: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/global/seaice/eng.yymmdd Archived Data: ftp://is.sci.gsfc.nasa.gov/ArchivedAncillary/temporal/global/seaice/eng.yymmdd where yy, mm and dd represent the 2-digit year, month, and date respectively
noaa_oisst (required for all products)	National Oceanic and Atmospheric Administration (NOAA) Optimum Interpolation Sea Surface Temperature (OISST) (1 degree, global, weekly)	Current Data: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/global/sst/oisst.yyyymmdd Archived Data: ftp://is.sci.gsfc.nasa.gov/ArchivedAncillary/temporal/global/sst/oisst.yyyymmdd where yyyy, mm and dd represent the 4-digit year, month, and date respectively
noaa_toast (required for Aerosol products)	NOAA NCEP Total Ozone Analysis using SBUV/2 and TOV (TOAST) (daily, global)	Current Data: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/global/toast/TOAST16_yymmdd.GRB Archived Data: ftp://is.sci.gsfc.nasa.gov/ArchivedAncillary/temporal/global/toast/TOAST16_yymmdd where yy, mm and dd represent the 2-digit year, month, and date respectively

Input File Labels	Description	Source
modis_csrb (required for Cloudtop product)	MODIS Clear Sky Radiance Bias (CSRB) 8 day composite products. Files are available for Terra and Aqua.	Current Data: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/global/csrb/M<O|Y>CSR_B.AyyyyDDD.*.h5 Archived Data: ftp://is.sci.gsfc.nasa.gov/ArchivedAncillary/temporal/global/csrb/M<O|Y>DCSR_B.AyyyyDDD.*.h5 where yyyy, DDD represent the 4-digit year, and day-of-year of the start of the 8 day compositing period. The end of the compositing period is 8 days after the start date.

Parameter Labels	Description
platform	'aqua' or 'terra'
scandate	The start date of the L1B swath in yyDDD format where yy and DDD refers to the 2-digit year and day of the year respectively. If your input L1B files follow the standard Distributed Active Archive Center (DAAC) L1B file naming convention (e.g., M<O|Y>D021KM.AyyyyDDDhhmmss*.hdf; yyyy, DDD, hh, mm, ss represents the year, day of year, hour, minutes, seconds respectively for the start of the swath), this information can be found in the file name itself.
scantime	The start time of the L1B swath in hhmm format, where hh and mm refers to the 2-digit hour and 2-digit minutes respectively. If your input L1B files follow the standard DAAC L1B file naming convention (e.g., M<O|Y>D021KM.AyyyyDDDhhmmss*.hdf; yyyy, DDD, hh, mm, ss represents the year, day of year, hour, minutes, seconds respectively for the start of the swath), this information can be found in the file name itself.
cloudopt	'true' or 'false'. Default is 'true'. When 'false' the MODIS cloud optical property software (MOD06OD) software will not run and corresponding datasets will remain unpopulated in the MODIS Cloudtop Properties, Cloud Phase, Cloud Optical Properties (MOD06) product.

Output File Labels	Description	Output Format Description
modis.cloudmask (optional)	MODIS Cloudmask Level 2 (MOD35) output HDF file	Please refer to appropriate documentation under SPA/IMAPP/algorithm/doc/
modis.cloudmaskbyte (optional)	MODIS Cloudmask first byte output HDF file	
modis.aerosols (optional)	MODIS Aerosol Level 2 (MOD04) output HDF file	
modis.aerosols3km (optional)	MODIS Aerosol 3km Level 2 output HDF file	
modis.cloudtop (optional)	MODIS Cloudtop	

	Properties, Cloud Phase, Cloud Optical Properties Level 2 (MOD06) output HDF file	
modis.atmprofile (optional)	MODIS Atmospheric Profiles Level 2 (MOD07) output HDF file	

Execute the 'run': The following script shows an example of a command line to run the IMAPP_SPA algorithm from the testscripts directory. Download the latest leapsec and utcpole files from the locations listed in the table above into the directory of your choice. Next edit the command line below to update values for the 'leapsec' and 'utpole' labels to point to the downloaded leapsec and utcpole files. Now run the command line.

```
$../wrapper/IMAPP/run \
modis.mxd021km ../testdata/input/MOD021KM.A2010060.1525.005.2010264213349.hdf \
modis.mxd02hkm ../testdata/input/MOD02HKM.A2010060.1525.005.2010264213349.hdf \
modis.mxd02qkm ../testdata/input/MOD02QKM.A2010060.1525.005.2010264213349.hdf \
modis.mxd03 ../testdata/input/MOD03.A2010060.1525.005.2010264155619.hdf \
platform terra \
scandate 10060 \
scantime 1525 \
ssmi_nise ../testdata/input/NISE_SSMIF13_20100301.HDFEOS \
ssmi_seaice ../testdata/input/eng.100301 \
ncep_met_1 ../testdata/input/gdas1.PGrbF00.100301.18z \
ncep_met_1_prev ../testdata/input/gdas1.PGrbF00.100301.12z \
ncep_met_1_next ../testdata/input/gdas1.PGrbF00.100301.18z \
ncep_met_3_before ../testdata/input/gdas1.PGrbF00.100301.12z \
ncep_met_3_after ../testdata/input/gdas1.PGrbF00.100301.18z \
noaa_toast ../testdata/input/TOAST16_100301.GRB \
noaa_oisst ../testdata/input/oisst.20100303 \
modis_csrb ../testdata/input/MODCSR_B.A2010052.006.2015041040913.hdf \
leapsec ../testdata/input/leapsec.dat \
utcpole ../testdata/input/utcpole.dat \
modis.aerosols ../testdata/output/mod04.100601525.hdf \
modis.aerosols3km ../testdata/output/mod04_3k.100601525.hdf \
modis.cloudmask ../testdata/output/mod35.100601525.hdf \
modis.cloudmaskbyte ../testdata/output/mask_byte1.100601525.hdf \
modis.cloudtop ../testdata/output/mod06.100601525.hdf \
modis.atmprofile ../testdata/output/mod07.100601525.hdf
```

A successful execution usually requires about an hour or more (or about 15 minutes if the MOD06OD tarball is not installed), depending on the speed of your computer and the size of the input. 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 it and run again. If the problem has some other cause, it can be identified using the log files. Log files are automatically generated within the directory used for execution. They start with stdfile* and errfile* and can be deleted after execution. Other log and intermediate files may be generated automatically within the directory used for execution. They are useful for traceability and debugging purposes. However it is strongly recommended that users clean up log files and intermediate files left behind in the run directory before initiating a fresh execution of the SPA. Intermediate files from a previous run may affect a successive run

and produce ambiguous results. The 'run' can be executed from any directory the user chooses. This can be done by prefixing it with the file path for the 'run' script.

NOTES:

1. **Selective product processing:** The IMAPP_SPA will produce only those atmospheric products whose output labels were specified on the command line. For example, specifying only modis.cloudmask and modis.atmprofile labels on the command line will result in generation of only the cloudmask and profiles products. Output file format information for each product can be found in /SPA/IMAPP/algorithm/doc.
2. **Ancillary input files:** The SPA needs ancillaries to be provided on the command line. Some ancillaries are mandatory for all products, others are required for particular products only. Please refer to the Inputs Table above. Recommendations for choosing ancillary input files for a particular L1B granule are provided below for each ancillary label. It is important to note here that these ancillary choices will be made automatically by the IPOPP framework, should the user choose to run the SPA in IPOPP mode instead of standalone mode:

    - **leapsec and utcpole:** Leapsec and utcpole ancillaries are required for all products. Always use the latest leapsec and utcpole file regardless of the scantime.

    - **ssmi_nise & ssmi_seaice:** The ssmi_nise and ssmi_seaice files are required for all products. The dates for the NSIDC Near-real time Ice and Snow Extent (NISE) and NCEP sea ice datasets should be as close as possible to the dates of the L1B granules. Use an ancillary file that is within ±14 days of the scan date. The dates for the NISE and NCEP Sea Ice ancillary files are encoded in the filenames as NISE_SSMIF13_yyyymmdd.HDFEOS and eng.yymmdd respectively.

    - **noaa_oisst:** The noaa_oisst file is required for all products. The date of the Optimum Interpolation Sea Surface Temperature (OISST) weekly ancillary file should also correspond as closely as possible to the L1B scan time. Use an OISST ancillary file that is within ±28 days of the scan date. The date for the OISST file is encoded in the filename as oisst.yyyymmdd.

    - **noaa_toast:** The noaa_toast file is required only for the Aerosol and Aerosol 3km (MOD04) products. The dates of the ozone data should be as close as possible to the dates of the L1B granules. Use a TOAST ancillary file that is within ±14 days of the scan date. The dates for the TOAST ozone ancillary files are encoded in the filenames as TOAST16_yymmdd.GRB.

    - **ncep_met_1:** The ncep_met_1 file is required for all products. Either GDAS or Global Model Forecast Fields (GFS) files may be used for this label. Try to use a GDAS file that is within ±3 hours of the L1B granule. If that file is not available (as is often the case for real-time processing), use a GFS file instead. The naming

convention for grib1 GFS files is gfs.thh.yymmdd.pgrbfxx (Here yymmddd and hh represent analysis time, and xx represents forecast time step). Thus a file named gfs.t12.100201.pgrbf03 corresponds to 1500 hours (12+3) UTC on February 1, 2010. If you have to choose GFS data as input, you should attempt to use a file that is within ±1.5 hours of the L1B file. If there is more than one such GFS file, use the one with the smaller forecast time step. For example, if your data time is 15 UTC, you should try to use the 3 hour forecast field from the 1200 UTC model run, instead of the 9 hour forecast field from the 0600 UTC run.

- **ncep_met_1_prev, ncep_met_1_next:** ncep_met_1_prev and ncep_met_1_next are recommended for all products, but at least one of the two must be provided. The type (GDAS or GFS) of these ancillaries depends on the type used for the 'ncep_met_1' ancillary. If ncep_met_1 is of GDAS type then choose a GDAS file that is less than 6 hours before the scantime for ncep_met_1_prev and a GDAS file that is less than 6 hours after the scantime for ncep_met_1_next. If ncep_met_1 is of GFS type then choose a 12 hour-time-step GFS file (i.e., a gfs.thh.yymmdd.pgrbfxx where xx=12)) that is less than 6 hours before the scantime for ncep_met_1_prev and a 12 hour-time-step GFS file that is less than 6 hours after the scantime for ncep_met_1_next.

- **ncep_met_3_before & ncep_met_3_after:** ncep_met_3_before and ncep_met_3_after ancillaries are required only for the MODIS Cloudtop Properties, Cloud Phase, Cloud Optical Properties (MOD06) product. ncep_met_3_before should be the closest GDAS within the 6 hours prior to the L1B time. If a GDAS file is not found use a GFS file within the 3 hours prior to the L1B time. If you have more than one GFS file satisfying the latter criterion, use the one with the smallest forecast step. If a GDAS/GFS file is not found for the same day as the L1B, you may use a GDAS file from within ±7 days as long as its time is within the 6 hours before the L1B time. The logic for selecting a ncep_met_3_after file is similar except that it should be after the L1B time.

- **modis_csrb:** The modis_csrb file is required only for the MODIS Cloudtop Properties, Cloud Phase, Cloud Optical Properties (MOD06) product. The ending date for the 8-day-composite MODIS Clear Sky Radiance Bias (CSRB) dataset should be as close as possible but within the last 20 days of the scan date. Note that the end date of the CSRB is not encoded in the filename; it can be computed by adding 8 days to the encoded compositing start date. Make sure that the CSRB file you use (Terra or Aqua) matches the platform corresponding to your L1B files. The date and platform of a CSRB file is encoded in the filename as M<Y|O>DCSR_B.Ayyyyddd.005.*.hdf (Y-Aqua; O-Terra).

3. **Aerosols:** The IMAPP_SPA will not produce the aerosol products if there is an insufficient number of daytime scans

4. **Cloud Optical Properties Datasets:** The IMAPP_SPA will not populate the Cloud Optical Properties Datasets within the MODIS Cloudtop Properties, Cloud Phase,

Cloud Optical Properties (MOD06) product if there is an insufficient number of daytime scans

To Use the Scripts in the testscripts Directory

One simple way to run the algorithms from the directory of your choice using your own data is to copy the run_TERRA_IMAPP.sh script from the testscripts directory to the selected directory. Change the values of the variables like WRAPPERHOME, INPUTHOME and OUTPUTHOME to reflect the file paths of the wrapper directories and the input/output file paths. Then modify the input/output file name variables. Run the script to process your data.

Appendix A
SPA Services

Installation of this SPA in IPOPP mode will make the SPA services listed in Table A-1 available to IPOPP. These SPA services along with any other prerequisite SPA services (listed in Table A-2) will need to be enabled to allow IPOPP to automate production of the IMAPP_SPA data products. Furthermore, users who wish to generate image products from the data products generated by this SPA will need to enable the image-generating SPA services listed in Table A-3. The SPAs containing the prerequisite and the image-generating SPA services listed in Tables A-2 and A-3 can be downloaded from the DRL Web Portal, in case they are not already available in your IPOPP installation. Details about these other SPAs are available in the respective SPA User's Guides. Please refer to the IPOPP User's Guide for instructions on how to install an SPA in IPOPP and enable the corresponding SPA services.

Table A-1. SPA Services

<table>
<tr><th>SPA services for this SPA</th><th>Data Products produced</th></tr>
<tr><td>IMAPP</td><td>
<table>
<tr><th>Product Name</th><th>Destination
(when installed in IPOPP)</th></tr>
<tr><td>MODIS Cloudmask Level 2 (MOD35)</td><td>$HOME/drl/data/pub/gsfcdata/<terra|aqua>/modis/level2/CLOUDMASK.yyDDDhhmmss.hdf[1]</td></tr>
<tr><td>MODIS Atmospheric Profiles Level 2 (MOD07)</td><td>$HOME/drl/data/pub/gsfcdata/<terra|aqua>/modis/level2/PROFILES.yyDDDhhmmss.hdf[1]</td></tr>
<tr><td>MODIS Aerosol Level 2 (MOD04) (Daytime only)</td><td>$HOME/drl/data/pub/gsfcdata/<terra|aqua>/modis/level2/AEROSOL.yyDDDhhmmss.hdf[1]</td></tr>
<tr><td>MODIS Aerosol 3km Level 2 (MOD04_3K) (Daytime only)</td><td>$HOME/drl/data/pub/gsfcdata/<terra|aqua>/modis/level2/AEROSOL3KM.yyDDDhhmmss.hdf[1]</td></tr>
</table>
</td></tr>
<tr><td>IMAPP-Cloudtop</td><td>
<table>
<tr><th>Product Name</th><th>Destination
(when installed in IPOPP)</th></tr>
<tr><td>MODIS Cloudtop Properties, Cloud Phase, and Cloud Optical Properties Level 2 (MOD06) (The Cloud Optical Properties datasets are Daytime only).</td><td>$HOME/drl/data/pub/gsfcdata/<terra|aqua>/modis/level2/CLOUDTOP.yyDDDhhmmss.hdf[1]</td></tr>
</table>
</td></tr>
</table>

[1] Where *yy*, *DDD*, *hh, mm, ss* represents the 2-digit year, day of year, hour, minute and seconds respectively for the start of swath

Table A-2. Prerequisite SPA services

Prerequisite SPA services	SPA in which they are available
gbad	GBAD_SPA
l0l1terra	MODISL1DB_SPA
l0l1aqua	MODISL1DB_SPA
l1atob	MODISL1DB_SPA

Table A-3. Image-generating SPA services

Image-generating SPA services	SPA in which they are available
ctp-geotiff	H2G_SPA
cloudmask-geotiff	H2G_SPA
aerosols-geotiff	H2G_SPA
irphase-geotiff	H2G_SPA
atmprofile-geotiff	H2G_SPA

NOTE: Please refer to the H2G_SPA User's Guide for more details about the image products, including their locations and filename patterns when they are generated in IPOPP.