MODIS Level 3 Burn Scar Science Processing Algorithm (BURNSCAR_SPA) User's Guide

Version 1.1

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GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

MODIS Level 3 Burn Scar Science Processing Algorithm

BURNSCAR_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 (SNPP), 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 DRL software package contains the MODIS Burn Scar Science Processing Algorithm (BURNSCAR_SPA). The algorithm maps post-fire burned areas using daily composites of 500m MODIS corrected reflectance and daily composites of 1km MODIS active fire observations. It identifies the date of burn, to the nearest day, for 500m grid cells within individual MODIS Level 3 tiles. While the resulting burned area maps are not yet produced in near-real time, this implementation requires relatively modest mass storage and computational resources and is thus well suited for use in a Direct Broadcast environment. The 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. The SPA uses Version 1.1 of the Burn Scar algorithm.

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

a) Fedora 18 X86_64;

b) CentOS Linux 6.3 X86_64;

c) OpenSUSE Linux 12.1 X86_64;

d) Kubuntu 12.04 X86_64.

Credits

The MODIS Level 3 Burn Scar Science Processing Algorithm (Version 1.1, May 2013) was co-developed by the NASA Land Science Team 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.

Program Inputs and Outputs

This SPA uses Level 2 Corrected Reflectance (CREFL) and Level 2 Active Fires (MOD14) swath products as inputs to produce intermediate outputs of CREFL and MOD14 daily composite tiles. The intermediate outputs of CREFL and MOD14 Daily Composites are then used as inputs to produce the final post-fire PRESCAR and BURNSCAR tile products.

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.

NOTE: The installation of the BURNSCAR_SPA into the IPOPP framework requires additional pre-configuration instructions that differ from the installation instructions for other SPAs. Please refer to Appendix A, "Pre-configuration for Installation into IPOPP."

Download the BURNSCAR_1.1_SPA_1.1.tar.gz and
BURNSCAR_1.1_SPA_1.1_testdata.tar.gz (optional) files into the same directory.

Decompress and un-archive the BURNSCAR_1.1_SPA_1.1.tar.gz and
BURNSCAR_1.1_SPA_1.1_testdata.tar.gz (optional) files:

```
$ tar -xzf  BURNSCAR_1.1_SPA_1.1.tar.gz
$ tar -xzf  BURNSCAR_1.1_SPA_1.1_testdata.tar.gz
```

This will create the following subdirectories:

```
SPA
    burnscar
        algorithm
        ancillary
        station
        wrapper
        testscripts
        testdata
```

This package contains 64-bit binaries statically pre-compiled on an Intel-compatible 64-bit computer running under Fedora Core 14, using gcc 4.5.1. The binaries should work on most Linux OS/platforms. If you get an error message while running the testscripts (refer to the next section, "Software Package Testing and Validation"), you may need to recompile the software for your platform/OS combination.

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 BURNSCAR_1.1_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 following scripts in the order given below:

```
$./run-1-creflhkm
$./run-2-creflcompositor
$./run-2-mod14compositor
$./run-3-burnscar-default
```

Successful execution of each script usually takes approximately 2 to 10 minutes, depending on the speed of your computer, so if the execution seems to get stuck, do not become impatient. If everything is working properly, the scripts will terminate with messages such as:

```
$./run-1-creflhkm

Output modis.creflhkm is
/home/ipopp/drl/SPA/burnscar/testdata/L2/MYDcreflhkm.08239110339.hdf

$./run-2-creflcompositor

Output modis.creflhkm_tile is
/home/ipopp/drl/SPA/burnscar/testdata/DailyComposites/MXDcreflhkm.h21v10.08239.hdf
Output modis.geo_tile is null

$./run-2-mod14compositor

Output modis.firedetection_tile is
/home/ipopp/drl/SPA/burnscar/testdata/DailyComposites/MXD14.h21v10.08239.hdf
Output modis.geo_tile is null

$./run-3-burnscar-default

Output modis.prescar_tile is
 /home/ipopp/drl/SPA/burnscar/testdata/BurnScar/PRESCAR.h21v10.2008.215.245.hdf
Output modis.burnscar_tile is
/home/ipopp/drl/SPA/burnscar/testdata/BurnScar/BURNSCAR.h21v10.2008.215.245.hdf
```

You can cd to the corresponding product output directories to verify that the science products exist. Test output product(s) are available for comparison in the testdata/testoutput directory. These test output product(s) were generated on a 64-bit PC architecture computer running Linux Fedora Core 14. Use a comparison utility (such as diff, hdiff, etc) to compare your output(s) to those provided in the testdata/testoutput directory.

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. Other problems may be caused by incompatibility between your system and the binaries provided with this software package. In that case you may need to recompile the software for your platform/OS combination. Please report any errors that cannot be resolved to the DRL.

NOTE: In order to keep the testdata package at a manageable size, the testscripts included in the testdata package use a single day of daily composites to generate PRESCAR and BURNSCAR output products. This has been done for testing purposes only. The BURNSCAR_SPA requires an extended time series of daily composites to reliably map burned areas.

Program Operation

Generating a burnscar product is a five step process:

Step 1: Create MOD14 swath products.

Step 2: Create CREFL half-km swath products.

Step 3: Create MOD14 daily composite tiled products.

Step 4: Create CREFL half-km daily composite tiled products. Steps 1 through 4 must be repeated for multiple days.

Step 5: Create Level 3 Prescar and Burnscar tiled products (using multiple days of CREFL and MOD14 daily composites).

Figure 1 depicts the five-step procedure. In order to execute the steps 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.

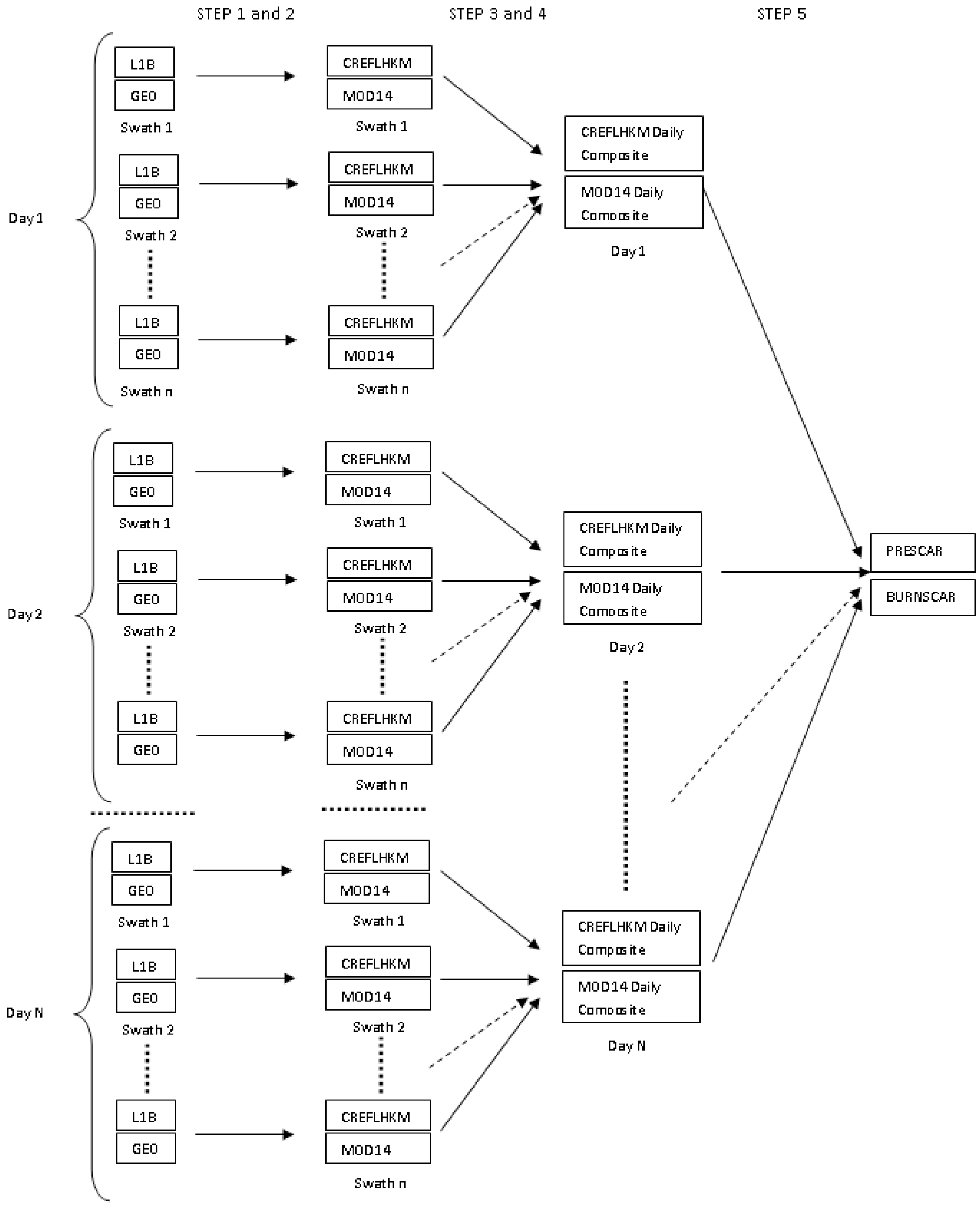

Figure 1. Creating Post-fire Prescar and Burnscar Products

To Use the Run Scripts

Identify the 'run' scripts: The MOD14_SPA must be used in Step 1 to create the MOD14 swath products. (The MOD14_SPA is available for download at the DRL Web Portal.)

For the rest of the four subsequent steps there is a separate 'run' script within the SPA/burnscar/wrapper/<wrapper-subdir> subdirectories that must be executed. Users must execute the 'run' within the correct wrapper subdirectory in order to execute the corresponding step. The 'run' for creating CREFL half-km swath products can be found in the SPA/burnscar/wrapper/creflhkm directory, while the 'run' for creating MOD14 daily composites and CREFL daily composites can be found in the SPA/burnscar/wrapper/mod14-composite and SPA/burnscar/wrapper/crefl-composite subdirectories, respectively. The 'run' for executing the final step of creating prescar and burnscar products can be found in the SPA/burnscar/wrapper/burnscar subdirectory. Note that to execute the 'run's, you need to have java in your path.

Specify input parameters using <label value> pairs: To execute the 'run' scripts, you must supply the required command line parameters. 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 were not supplied. There are three kinds of label/value pairs used by the BURNSCAR_SPA use, 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 on to the SPA (e.g., cloud threshold).

c) Output file labels. These are output files that are produced by a process. Values are the relative/absolute paths of the files you wish to generate.

Table 1 lists and describes the input, output and parameter labels associated with each of the five steps required to create a burnscar product.

Table 1. Labels

Step 1: Create MOD14 swath products: *Please refer to the MOD14_SPA User's Guide.*
Step 2: Create CREFL half-km swath products: *use SPA/burnscar/wrapper/creflhkm/run*

Input Labels	Description
modis.mxd021km	MODIS 1km L1B Calibrated Geolocated Radiances hdf file (MOD021KM, MYD021KM) DRL ftp site for real-time Terra MODIS Level 1 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/terra/modis/level1/ DRL ftp site for real-time Aqua MODIS Level 1 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/modis/level1/
modis.mxd02hkm	MODIS 500m L1B Calibrated Geolocated Radiances hdf file (MOD02HKM, MYD02HKM) DRL ftp site for real-time Terra MODIS Level 1 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/terra/modis/level1/ DRL ftp site for real-time Aqua MODIS Level 1 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/modis/level1/
modis.mxd02qkm	MODIS 250m L1B Calibrated Geolocated Radiances hdf file (MOD02QKM, MYD02QKM) DRL ftp site for real-time Terra MODIS Level 1 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/terra/modis/level1/ DRL ftp site for real-time Aqua MODIS Level 1 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/modis/level1/
Output Label	**Description**
modis.creflhkm	Half-km Corrected Reflectance product

Step 3: Create MOD14 daily composite tiled products:

use SPA/burnscar/wrapper/mod14-composite/run

Input Labels	Description
modis.mxd03_*x (x is a value between 1 and 12)*	MODIS Geolocation products. Up to 12 geolocation products can be used as input.

	All geolocation products used must be from the same day. (See Notes 1 and 2.) DRL ftp site for real-time Terra MODIS Level 1 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/terra/modis/level1/ DRL ftp site for real-time Aqua MODIS Level 1 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/modis/level1/
modis.firedetection_*x* (*x is a value between 1 and 12*)	MODIS L2 MOD14 (Active Fire) products. Up to 12 MOD14 products can be used as input. All MOD14 products used must be from the same day. (See Notes 1 and 2.) DRL ftp site for real-time Terra MODIS Level 2 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/terra/modis/level2/ DRL ftp site for real-time Aqua MODIS Level 2 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/modis/level2/

Parameter Labels	Description
tileID	MODIS tileID representing geographic location of the output tile. (See Appendix B,"MODIS Tiling System.")

Output Labels	Description
modis.firedetection_tile	Level 3 MOD14 daily composite tiled product. (See Note 4.)

Step 4: Create CREFL half-km daily composite tiled products

use SPA/burnscar/wrapper/crefl-composite/run

Input Labels	Description
modis.mxd03_*x (x is a value between 1 and 12)*	MODIS Geolocation products. Up to 12 geolocation daytime products can be used as input. All geolocation products used must be from the same day. (See Notes 1 and 2.) DRL ftp site for real-time Terra MODIS Level 1 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/terra/modis/level1/

	DRL ftp site for real-time Aqua MODIS Level 1 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/modis/level1/
modis.firedetection_*x* (*x is a value between 1 and 12*)	MODIS L2 MOD14 (Active Fire) products. Up to 12 MOD14 daytime products can be used as input. All MOD14 products used must be from the same day. (See Notes 1 and 2.) DRL ftp site for real-time Terra MODIS Level 2 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/terra/modis/level2/ DRL ftp site for real-time Aqua MODIS Level 2 over the eastern US region: ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/modis/level2/
modis.creflhkm_*x (x is a value between 1 and 12)*	MODIS L2 CREFL half km products. Up to 12 CREFL half km daytime products can be used as input. All MODIS L2 CREFL half-km products used must be from the same day. (See Notes 1, 2, and 3.)
Parameter Labels	**Description**
tileID	MODIS tileID representing geographic location of the output tile. (See Appendix B, "MODIS Tiling System.")
Output Labels	**Description**
modis.creflhkm_tile	Level 3 CREFL half-km daily composite tiled product. (See Note 4.)
Step 5: Create Level 3 Prescar and Burnscar tiled products *use SPA/burnscar/wrapper/burnscar/run*	

Input Labels	Description
inputpath	Path to the directory where all MOD14 and CREFLHKM tiles are being accumulated every day. (See Note 4 and Appendix A, "Pre-configuration for Installation into IPOPP".)
Parameter Labels	**Description**
tileID	MODIS tileID representing geographic location of the input & output tiles. (See Appendix B, "MODIS Tiling System.")
year	Calendar year of time period over which burns are to be mapped.
startday	Start day of year of time period for which burns are to be mapped, e.g., when the mapping year is 2008, a start day of 275 would correspond to 1 October 2008. (See Note 5 for mapping periods and data staging requirements.)
endday	End day of year of time period for which burns are to be mapped, e.g. when the mapping year is 2008, an end day of 305 would correspond to 31 October 2008. (See Note 5 for mapping periods and data staging requirements.)
windowsize (optional)	Averaging window size (days); default is 10. (See Note 6 for recommendations on parameter usage.)
trmean_prc (optional)	Trimmed mean percentile; default is 10%. Averaging window size (days); default is 10. (See Note 6 for recommendations on parameter usage.)
cloudthreshold (optional)	Red band residual cloud reflectance threshold; default is 0.25. Averaging window size (days); default is 10. (See Note 6 for recommendations on parameter usage.)
waterthreshold (optional)	Band 7 residual water reflectance threshold; default is 0.02. Averaging window size (days); default is 10. (See Note 6 for recommendations on parameter usage.)
timeseriesextend (optional)	Number of extra days by which to extend

	time series; default is 16 days. (See Note 5 for mapping periods and data staging requirements.)
autoset (optional)	Setting this to 'true' will enable the autoset mode. Setting this to 'false' will disable the autoset mode. When not specified, the autoset mode is enabled by default. In its autoset-enabled mode, the SPA uses reasonable tile-specific settings for various run-time parameters, including the above five parameters for almost any tile that a user is likely to process. (See Note 6 for recommendations on parameter usage.)
Output Labels	**Description**
modis.prescar_tile	Level 3 Prescar tile product. (See Appendix C, "Description of Prescar and Burnscar Output Files.")
modis.burnscar_tile	Level 3 Burnscar tile product. (See Appendix C, "Description of Prescar and Burnscar Output Files.")

NOTE 1: A day is usually defined as the period between 0.00.00 UTC - 23.59.59 UTC.

NOTE 2: Care should be taken so that geolocation, MOD14, and CREFL products from the same swath appear with similarly numbered labels.

NOTE 3: No special procedure is required to identify daytime granules since the creflhkm process (Step 2) does not create CREFL half-km products for nighttime swaths.

NOTE 4: CREFL and MOD14 daily tiled products must conform to the following naming convention for the burnscar process (Step 5) to be able identify and process them:

CREFL daily tiled products :MXDcreflhkm.h*xx*v*ww*.YYDDD.hdf
e.g., MXDcreflhkm.h21v10.08239.hdf

MOD14 daily tiled products: MXD14.h*xx*v*ww*.YYDDD.hdf
e.g., MXD14.h21v10.08239.hdf

'hxxvww' refers to the MODIS tileID. (See Appendix B, "MODIS Tiling System.) 'YY' represents 2-digit year and 'DDD' represents 3-digit Julian day. All daily composite tiles must be accumulated in one directory. The path to this directory will serve as the value of the *inputpath* variable during creation of the prescar and burnscar products.

NOTE 5: This SPA requires an extended time series of daily composites to reliably map burned areas. By default, the PRESCAR temporal composting code will search for and use 30 days of daily CREFL and MOD14 composites *prior to* the first day of the mapping period, and another 30 days of daily CREFL and MOD14 composites *after* the last day of the mapping period. (Thus to reliably map burned areas over a one-month time period, 90 days of data are required.) The duration of this extended search window may be shortened (at the cost of some reduction in the quality of the final burned area maps) by assigning a value to the optional *timeseriesextend* parameter. The default value is 16 days. The minimum permissible value for this parameter is 1 day; at this setting the duration of the extended search window would be 14 days. Please note that it is not possible to run the code with an extended search period of less than 14 days before and after the specified mapping period.

When specifying the mapping period it is important to keep the duration of the extended search window in mind. If the *endday* parameter is set too close to the current date (i.e., nominally within 30 days of the current date), then the mapping algorithm will have less "look ahead" to use in the daily input time series, and the quality of the resulting burned area maps will be degraded. In general, the last day of the mapping period (*endday*) should be at least 14 + *timeseriesextend* days behind real time (i.e., 30 days by default).

NOTE 6: When autoset is set to 'true', the autoset mode is enabled. In this mode the SPA uses geographically appropriate values for various run-time parameters, including windowsize, trmean_prc, cloudthreshold, waterthreshold, and timeseriesextend. When autoset is set to false, the automatic parameter setting feature is disabled and the SPA uses default values for these parameters (see Table 1). If the autoset label is not specified on the command line, then the autoset mode will be enabled by default. Users who wish to override the values used by default in the autoset-enabled or the autoset-disabled mode may do so by additionally specifying that particular label. It is recommended to run the SPA in autoset-enabled mode.

Execute the 'runs': The following are examples of command lines to execute the steps required to generate the final prescar and burnscar products. You can run them from any directory of your choice by using the correct paths to the 'run' script and your datasets.

<u>Step 1: Create MOD14 swath products</u>
Refer to the MOD14_SPA User's Guide.

Step 2: Create CREFL half-km swath products

```
$../wrapper/creflhkm/run \
   modis.mxd02qkm ../testdata/L1/MYD02QKM.08239110339.hdf \
   modis.mxd02hkm ../testdata/L1/MYD02HKM.08239110339.hdf \
   modis.mxd021km ../testdata/L1/MYD021KM.08239110339.hdf \
   modis.creflhkm ../testdata/L2/MYDcreflhkm.08239110339.hdf
```

```
Output modis.creflhkm is
/home/ipopp/drl/SPA/burnscar/testdata/L2/MYDcreflhkm.08239110339.hdf
```

Step 3: Create MOD14 daily composite tiled products

```
../wrapper/mod14-composite/run \
    modis.mxd03_1 ../testdata/L1/MOD03.08239064512.hdf \
    modis.firedetection_1 ../testdata/L2/MOD14.08239064512.hdf \
    modis.mxd03_2 ../testdata/L1/MOD03.08239081914.hdf \
    modis.firedetection_2 ../testdata/L2/MOD14.08239081914.hdf \
    modis.mxd03_3 ../testdata/L1/MYD03.08239110339.hdf \
    modis.firedetection_3 ../testdata/L2/MYD14.08239110339.hdf \
    modis.mxd03_4 ../testdata/L1//MYD03.08239124118.hdf \
    modis.firedetection_4 ../testdata/L2/MYD14.08239124118.hdf \
    modis.firedetection_tile ../testdata/DailyComposites/MXD14.h21v10.08239.hdf \
    tileID h21v10
```

```
Output modis.firedetection_tile is
/home/ipopp/drl/SPA/burnscar/testdata/DailyComposites/MXD14.h21v10.08239.hdf
Output modis.geo_tile is null
```

Step 4: Create CREFL half-km daily composite tiled products

```
../wrapper/crefl-composite/run \
    modis.creflhkm_1 ../testdata/L2/MODcreflhkm.08239064512.hdf \
    modis.mxd03_1 ../testdata/L1/MOD03.08239064512.hdf \
    modis.firedetection_1 ../testdata/L2/MOD14.08239064512.hdf \
    modis.creflhkm_2 ../testdata/L2/MODcreflhkm.08239081914.hdf \
    modis.mxd03_2 ../testdata/L1/MOD03.08239081914.hdf \
    modis.firedetection_2 ../testdata/L2/MOD14.08239081914.hdf \
    modis.creflhkm_3 ../testdata/L2/MYDcreflhkm.08239110339.hdf \
    modis.mxd03_3 ../testdata/L1/MYD03.08239110339.hdf \
    modis.firedetection_3 ../testdata/L2/MYD14.08239110339.hdf \
    modis.creflhkm_4 ../testdata/L2/MYDcreflhkm.08239124118.hdf \
    modis.mxd03_4 ../testdata/L1/MYD03.08239124118.hdf \
    modis.firedetection_4 ../testdata/L2/MYD14.08239124118.hdf \
   modis.creflhkm_tile ../testdata/DailyComposites/MXDcreflhkm.h21v10.08239.hdf \
    tileID h21v10
```

```
Output modis.creflhkm_tile is
/home/ipopp/drl/SPA/burnscar/testdata/DailyComposites/MXDcreflhkm.h21v10.08239.hdf
Output modis.geo_tile is null
```

Step 5: Create Level 3 Prescar and Burnscar tiled products

Before executing Step 5, multiple days of CREFL and MOD14 daily composites must be staged in the directory specified by the *inputpath* label. See Note 5 for mapping periods and data staging requirements.

```
../wrapper/burnscar/run \
    inputpath ../testdata/DailyComposites \
    modis.prescar_tile ../testdata/BurnScar/PRESCAR.h21v10.2008.215.245.hdf \
    modis.burnscar_tile ../testdata/BurnScar/BURNSCAR.h21v10.2008.215.245.hdf \
    year 2008 \
    startday 215 \
    endday 245 \
    tileID h21v10
```

```
Output modis.prescar_tile is
/home/ipopp/drl/SPA/burnscar/testdata/BurnScar/PRESCAR.h21v10.2008.215.245.hdf
Output modis.burnscar_tile is
/home/ipopp/drl/SPA/burnscar/testdata/BurnScar/BURNSCAR.h21v10.2008.215.245.hdf
```

A successful execution of the 'run's usually take some time (around 2 -10 minutes, depending on the speed of your computer), so if the execution seems to get stuck, do not become impatient. 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. These start with the prefixes "stdfile*" and "errfile*", and are automatically generated within the directory used for execution. The executions may create some temporary files (or symbolic links) in your execution directory. Delete them after the run. 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. Other problems may be caused by incompatibility between your platform/OS and the binaries provided with this software package. In that case you may need to recompile the software for your platform/OS combination.

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 test scripts from the testscripts directory to the selected directory. Change the values of the variables WRAPPERHOME, L1HOME, OUTPUTHOME, etc to reflect the file paths of the wrapper directories, the input/output file paths and the command line parameters. Run the scripts to process your data.

Appendix A

Pre-configuration for Installation into IPOPP

Installation of this SPA into the IPOPP framework requires two pre-configuration steps:

1. Identify the MODIS tile(s) to process based on the geographic region of interest. (See Appendix B for an explanation of the MODIS tiling system). To do this, cd to the SPA/burnscar/algorithm directory and edit the ipopp_TileList.cfg file. This file includes a list of tileIDs on successive lines. Please add the tileIDs you want IPOPP to process on separate lines and delete the rest.
2. In the SPA/burnscar/algorithm directory run

   ```
   $./configure
   ```

   This will create the required stations to create the daily composite tiles.

At this point the SPA is ready for dynamic installation into the IPOPP framework. Detailed Instructions for this type of installation are contained in the IPOPP User's Guide. This SPA once installed into IPOPP will create the following Control System (CS) stations:

- creflhkm: This CS station will create the corrected reflectance swath products in half-km resolution.
- mod14-composite_hxxvyy: There will be one such CS station for each tile that was specified in the ipopp_TileList.cfg file. This station incrementally creates the daily composites of the MOD14 product.
- crefl-composite_hxxvyy: There will be one such CS station for each tile that was specified in the ipopp_TileList.cfg file. This CS station incrementally creates the daily composites of the CREFL product.

Make sure to run all these CS stations in IPOPP mode. Detailed Instructions for running CS stations are contained in the IPOPP User's Guide.

The mod14-compositor and crefl-compositor CS stations installed in IPOPP create and accumulate daily composite tiles of CREFL and MOD14 inside SPA/burnscar/algorithm/data/composites directory. The latter directory was designed to not be under IPOPP file management control. This allows the user to accumulate and retain as many daily composites as necessary to create prescar and burnscar products for the desired mapping period(s). See NOTE 5 for mapping periods and data staging requirements.

NOTE: Users should take care not to delete or modify the contents of the SPA/burnscar/algorithm/data/composites directory while running the SPA in IPOPP mode. Users who are re-installing this SPA in IPOPP mode should copy existing daily CREFL and MOD14 composite files in the SPA/burnscar/algorithm/data/composites directory to a safe location before deleting the existing SPA. Once the new BURNSCAR_SPA is installed, the copied files should be transferred into the SPA/burnscar/algorithm/data/composites directory in the new installation.

This version of the BURNSCAR_SPA is not configured to generate the final prescar and burnscar products in IPOPP mode. Generation of prescar and burnscar products can only be done in Standalone mode. While executing Step 5, users may point the "inputpath" parameter (see Table 1) to the SPA/burnscar/algorithm/data/composites directory where daily composites are being accumulated in IPOPP mode.

Appendix B

MODIS Tiling System

The standard MODIS Level 3 products are produced on a global sinusoidal grid that is divided into fixed tiles approximately 10° × 10° (at equator) in size, as depicted in Figure B-1.

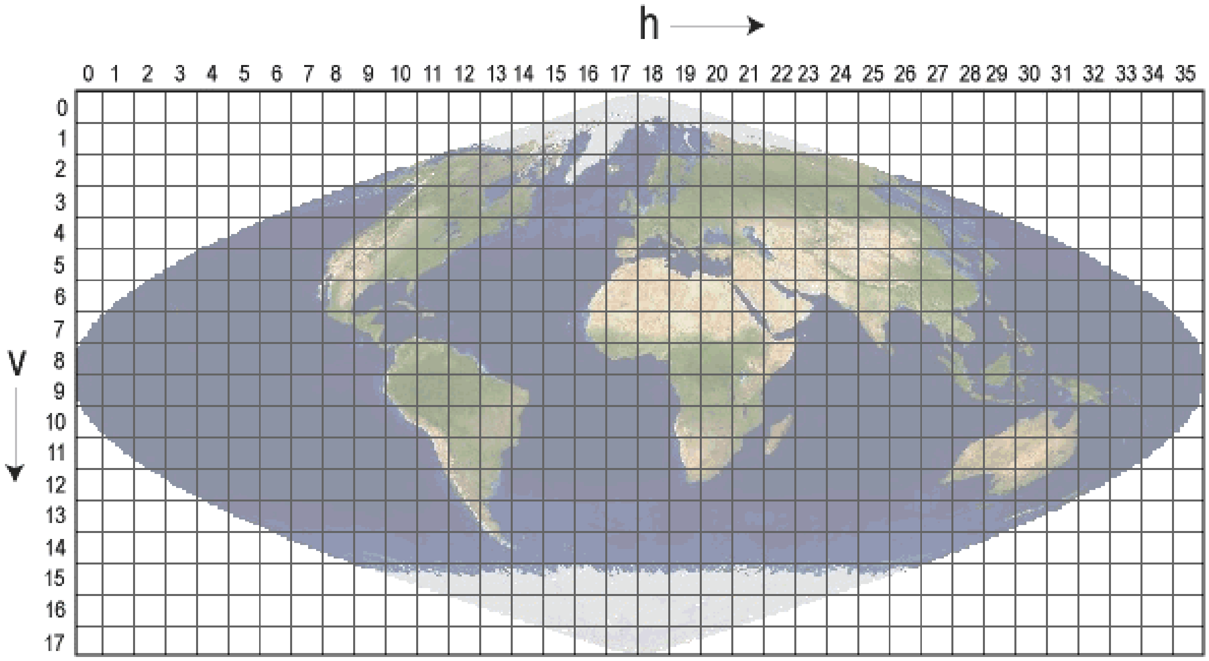

Figure B-1. MODIS Tiling System
(source http://modis-land.gsfc.nasa.gov/MODLAND_grid.htm)

For compatibility with the standard MODIS products, we employ this same tiling scheme within our Direct Broadcast implementation, i.e., the spatial extent of the final burned area map will always be a full MODIS tile. The tile coordinate system starts in the upper left corner at (0,0) (horizontal tile number, vertical tile number) and proceeds right (horizontal) and downward (vertical) to the tile in the bottom right corner at (35,17). Each tile can be identified by its tileID, which is of the form hXXvYY (XX and YY are the horizontal and vertical tile numbers). For example, the tile at (20,5) is referenced as h20v05.

NOTE: The BURNSCAR_SPA supports only MODIS land tiles.

Appendix C
Description of Prescar and Burnscar Output Files

The production of the burned area map for a given mapping period is a two-stage process. During the first stage ("Prescar"), the daily corrected-reflectance and active-fire time series are processed to generate a pixel-level composite change summary (or "temporal composite") for the mapping period. This temporal composite is then used as an input to the second stage ("Burnscar"), which performs the actual classification into burned and unburned pixels.

Prescar Temporal-composite Files

The change summary generated during the initial Prescar stage is written in the form of multiple data layers, or Scientific Data Sets (SDSs), within an HDF4 output file (Table B-2). While the majority of these data layers are included solely to satisfy the particular input requirements of the classification phase of the algorithm, and are therefore not "end results" or products in themselves, several layers provide information that may be of interest to users. The FireMask SDS contains a cumulative map of fires detected by the Terra and Aqua MODIS sensors during the mapping period. The FirstDay and LastDay SDSs indicate the first and last date, respectively, on which changes could be reliably detected within the time series, on a per-pixel basis. (Note that during periods of persistent cloud cover or frequent data loss these dates will often lie *within* the mapping period, indicating that reliable mapping could not be achieved over the full duration of the mapping period.)

For information about the remaining data layers, see Giglio et al. (2009).

Table B-2. Prescar SDSs

SDS Name	Units	Scale Factor	Description
FireDay	-	-	day on which active fire was observed
PostVI57	-	0.001	post-burn mean VI57
DeltaVI57	-	0.001	change in mean VI57
MaxSepVI57	-	0.01	maximum VI57 separability
PostR2	-	0.0001	post-burn mean band 2 reflectance
DeltaR2	-	0.0001	associated change in mean band 2 reflectance
PostR5	-	0.0001	post-burn mean band 5 reflectance
DeltaR5	-	0.0001	associated change in mean band 5 reflectance
PostR7	-	0.0001	post-burn mean band 7 reflectance
DeltaR7	-	0.0001	associated change in mean band 7 reflectance
ChangeDay	-	-	Day of maximum persistent change
FireMask	bit field	-	Cumulative fire mask bit 0: unused (reserved for VIRS) bit 1: Terra MODIS fire detecting during mapping period bit 2: Aqua MODIS fire detected during mapping period
DeltaT	days	-	Time interval of change
FirstDay	-	-	First day of reliable change detection
LastDay	-	-	Last day of reliable change detection
QA	bit field	-	Quality assurance flags
MaxDayWinIQR	days	-	Maximum of pre- and post-burn temporal-window interquartile range

Burnscar Burned-area Map Files

As with the initial Prescar stage of the processing, the final Burnscar stage produces an HDF4 file containing multiple data layers stored as SDSs. In the Direct Broadcast implementation of the code, only four SDSs are included in the final product (Table B-3). The primary *burn_day* SDS indicates the ordinal day of the year during which the grid cell burned (range 1-366). A value of zero indicates that the grid cell did not burn during the mapping period. Grid cells over water, as well as grid cells for which a classification could not be rendered due to excessive missing data in the input time series (usually the result of persistent cloud cover), are assigned a missing data value of -1. (Note that with the exception of the missing data value, this is the same convention used in the Roy et al. [2007] MCD45A1 burned area product.) The occurrence of missing observations in the time series introduces an inherent uncertainty in the estimated burn date; the algorithm estimates this uncertainty during the compositing phase and carries it into the final product in the SDS *burn_day_uncertainty*. For more information about the uncertainty estimate and the remaining data layers, see Giglio et al. (2009).

It is important to note that burn dates *outside* of the mapping period can occur in the final burned area maps. Such dates are left in the product solely to provide context and should not undergo further processing or analysis (grid cells having such dates are, by definition, mapped less reliably than those that burn *within* the mapping period). In particular, grid cells having burn dates outside of the mapping period should not be treated as a reliable indicator of fire activity outside of the mapping period. If burn dates before and/or after the mapping period are of interest, separate burned area maps should be produced specifically for these earlier and/or later time periods.

Table B-3. Burnscar SDSs

SDS Name	Units	Scale Factor	Description
burn_day	-	-	Ordinal day of year on which burn occurred (range 1 – 366) 0 = unburned during mapping period -1 = water/missing
burn_day_uncertainty	days	-	Uncertainty in day of burn
QA	bit field	-	Quality assurance flags bit 0: 1 = valid data, 0 = missing data or water bit 1: 1 = pixel ignored during processing and assumed unburned because observations in candidate pre- and post-burn window(s) span an excessively long time period, 0 = pixel not ignored bit 2: 1 = pixel forced to be classified as "unburned" because too few training pixels or insufficient spectral separability between burned and unburned pixels, 0 = no forced classification bit 3: 1 = pixel labeled as a burned training pixel during region growing but failed internal temporal consistency test, 0 = temporal consistency test passed or not applicable bit 4: internal diagnostic flag; currently this bit should be ignored
training_mask	-	-	Burned/unburned training mask 0 = water/missing 1 = non-training grid cell 2 = unburned training grid cell 3 = burned training grid cell
priors	-	0.005	Prior burned probability

References

Giglio, L., Loboda, T., Roy, D. P., Quayle, B., and Justice, C. O., 2009, An active-fire based burned area mapping algorithm for the MODIS sensor. *Remote Sensing of Environment*, 113, 408-420.

Roy, D. P., Jin, Y., Lewis, P. E., and Justice, C. O., 2005, Prototyping a global algorithm for systematic fire-affected area mapping using MODIS time series data. *Remote Sensing of Environment*, 97, 137-162.