VIIRS Aerosol Science Processing Algorithm (AEROSOL_SPA) User's Guide

Version 1.5.08.04

August 2014

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

VIIRS Aerosol Science Processing Algorithm

AEROSOL_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). 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 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 software package contains the Visible Infrared Imaging Radiometer Suite (VIIRS) Aerosol Science Processing Algorithm (AEROSOL_SPA). The VIIRS Aerosol algorithm takes as input VIIRS Moderate Resolution Bands Sensor Data Record (SDR) and Terrain-Corrected Geolocation products, the VIIRS Cloud Mask Intermediate Product (IP), and meteorological ancillary, and produces the mission-compliant Aerosol Optical Thickness (AOT) IP, Aerosol Model Index (AMI) IP, Aerosol Environmental Data Record (EDR), Suspended Matter (SM) EDR, and Aerosol Geolocation HDF5 product. 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 VIIRS Aerosol algorithm has been ported from the IDPS OPS Version 1.5.08.04.

Enhancements to this SPA include:

- algorithm updated to version 1.5.08.04;
- capability to process compressed and/or chunked HDF5 input files;
- updated Lookup Tables (LUTs).

This software will execute on a 64-bit computer and has been tested on computers with 32GB of RAM, with the following operating systems:

a) Fedora 18 X86_64;
b) CentOS Linux 6.4 X86_64;
c) OpenSUSE Linux 12.1 X86_64;
d) Kubuntu 13.04 X86_64.

Credits

The VIIRS Aerosol algorithm was provided to the DRL by the JPSS Mission. This algorithm was ported to run outside of the IDPS by the DRL in collaboration with the Land Product Evaluation and Algorithm Test Element (LPEATE).

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. This package contains 64-bit binaries statically pre-compiled on an x86-compatible 64-bit computer running under Fedora 14, using gcc 4.5.1.

Program Inputs and Outputs

The VIIRS Aerosol algorithm takes as input VIIRS Moderate Resolution Bands M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12, M15, and M16 Sensor Data Record (SDR) products, the VIIRS M-Band Terrain-Corrected Geolocation product, the VIIRS Cloud Mask Intermediate Product (IP), and meteorological ancillary to produce the mission-compliant Aerosol Optical Thickness (AOT) IP, Aerosol Model Index (AMI) IP, Aerosol Environmental Data Record (EDR), Suspended Matter (SM) EDR, and Aerosol Geolocation HDF5 products.

Installation and Configuration

Installing as a Standalone Application:

Download the AEROSOL_1.5.08.04_SPA_1.4.tar.gz and AEROSOL_1.5.08.04_SPA_1.4_testdata.tar.gz (optional) files into the same directory.

Decompress and un-archive the AEROSOL_1.5.08.04_SPA_1.4.tar.gz and AEROSOL_1.5.08.04_SPA_1.4_testdata.tar.gz (optional) files:

```
$ tar –xzf AEROSOL_1.5.08.04_SPA_1.4.tar.gz
$ tar –xzf AEROSOL_1.5.08.04_SPA_1.4_testdata.tar.gz
```

This will create the following subdirectories:

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

Installing into an IPOPP Framework: This SPA can also be installed dynamically into an IPOPP framework to automate production of AEROSOL_SPA data products. The SPA installation process will install SPA station(s) into IPOPP. An SPA station 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 station(s) corresponding to this SPA along with any other pre-requisite station(s). Instructions for installing an SPA and enabling its stations are contained in the IPOPP User's Guide (available on the DRL Web Portal). The SPA stations associated with this SPA are listed in Appendix A.

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 AEROSOL_1.5.08.04_SPA_1.4_testdata.tar.gz file is required to execute these testing procedures.

Step 1: cd into the testscripts directory.
Step 2: There is a script named run-vaerosol inside the testscripts directory.
To run the VIIRS Aerosol algorithm, use

```
$ ./run-vaerosol
```

A successful execution usually requires fifteen minutes or more, depending on the speed of your computer and the number of granules in the input. If everything is working properly, the

scripts will terminate with a message such as:

```
Output viirs.aot is /home/ipopp/drl/SPA/Aerosol/testdata/output/VAOOO.h5
Output viirs.aotip is /home/ipopp/drl/SPA/Aerosol/testdata/output/IVAOT.h5
Output viirs.amiip is /home/ipopp/drl/SPA/Aerosol/testdata/output/IVAMI.h5
Output viirs.gaero is /home/ipopp/drl/SPA/Aerosol/testdata/output/GAERO.h5
Output viirs.sum is /home/ipopp/drl/SPA/Aerosol/testdata/output/VSUMO.h5
```

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 Fedora 14. 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.

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 Aerosol. The subdirectory contains an executable called 'run'. Execute 'run' within the correct wrapper subdirectory to generate the corresponding product. For instance, the 'run' within wrapper/Aerosol is used for creating VIIRS Aerosol outputs. 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., 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 two types of <label value> pairs that the AEROSOL_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.

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

Input File Labels	Description	Source
ncep_met	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 GDAS and GFS files must be in grib1 format). Refer to the "NOTES" section below for more details regarding these meteorological ancillary file inputs.	Current Data: ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/global/gdas (for GDAS1) ftp://is.sci.gsfc.nasa.gov/ancillary/temporal/global/gfs (for GFS) Archived Data: ftp://is.sci.gsfc.nasa.gov/ArchivedAncillary/temporal/global/gdas (for GDAS1)
viirs.cmip	VIIRS Cloud Mask IP input HDF5 file path	1. The CLOUDMASK_SPA can be used to create this product. 2. Real time Cloud Mask IP products over the eastern US region are available from the DRL ftp site at: ftp://is.sci.gsfc.nasa.gov/gsfcdata/npp/viirs/level2/IICMO_npp_dyyyymmdd_thhmmssS_ehhmmssS*.h5 Where yyyy, mm, dd represents the year, month, and day of month for the start of the swath; the first hh, mm, ss, S represents the hour, minutes, seconds, and 10th of a second for the start of the swath and the second hh, mm, ss, S represents the end time of the swath. 3. Cloud Mask IP products for other locations and times are available for download at www.class.noaa.gov
viirs.gmtco	VIIRS M-Band Terrain-Corrected Geolocation input HDF5 file path	1. The C-SDR_SPA and VIIRS-SDR_SPA can be used to create these VIIRS SDR products. 2. Real time VIIRS SDR products over the eastern US region are available from the DRL ftp site at: ftp://is.sci.gsfc.nasa.gov/gsfcdata/npp/viirs/level1/<SVMxx|GMTCO>_npp_dyyyymmdd
viirs.svmxx {xx = 01 to 12, 15, 16}	VIIRS Moderate Resolution Band Mx {x = 1 to 12, 15, 16} SDR input HDF5 file path	

		_thhmmssS_ehhmmssS*.h5 Where yyyy, mm, dd represents the year, month, and day of month for the start of the swath; the first hh, mm, ss, S represents the hour, minutes, seconds, and 10th of a second for the start of the swath and the second hh, mm, ss, S represents the end time of the swath. 3. VIIRS SDR products for other locations and times are available for download at www.class.noaa.gov

Output File Labels	Description	Destination (when SPA is installed in IPOPP)
viirs.amiip	VIIRS Aerosol Model Index (AMI) IP output HDF5 file path	/raid/pub/gsfcdata/npp/viirs/level2/IVAMI_npp_dyyyymmdd_thhmmssS_ehhmmssS*.h5 Where yyyy, mm, dd represents the year, month, and day of month for the start of the swath; the first hh, mm, ss, S represents the hour, minutes, seconds, and 10th of a second for the start of the swath and the second hh, mm, ss, S represents the end time of the swath.
viirs.aot	VIIRS Aerosol EDR output HDF5 file path	/raid/pub/gsfcdata/npp/viirs/level2/VAOOO_npp_dyyymmdd_thhmmssS_ehhmmssS*.h5 Where yyyy, mm, dd represents the year, month, and day of month for the start of the swath; the first hh, mm, ss, S represents the hour, minutes, seconds, and 10th of a second for the start of the swath and the second hh, mm, ss, S represents the end time of the swath.
viirs.aotip	VIIRS Aerosol Optical Thickness (AOT) IP output HDF5 file path	/raid/pub/gsfcdata/npp/viirs/level2/IVAOT_npp_dyyymmdd_thhmmssS_ehhmmssS*.h5 Where yyyy, mm, dd represents the year, month, and day of month for the start of the swath; the first hh, mm, ss, S represents the hour, minutes, seconds, and 10th of a second for the start of the swath and the second hh, mm, ss, S represents the end time of the swath.
viirs.gaero	VIIRS Aerosol Geolocation output HDF5 file path	/raid/pub/gsfcdata/npp/viirs/level2/GAERO_npp_dyyymmdd_thhmmssS_ehhmmssS*.h5 Where yyyy, mm, dd represents the year, month, and day of month for the start of the swath; the first hh, mm, ss, S represents the hour, minutes, seconds, and 10th of a second for the start of the swath and the second hh, mm, ss, S represents the end time of the swath.

viirs.sum	VIIRS Suspended Matter (SM) EDR output HDF5 file path	/raid/pub/gsfcdata/npp/viirs/level1/VSUMO_npp_dyyyymmdd_thhmmssS_ehhmmssS*.h5 Where yyyy, mm, dd, hh represents the year, month and day of month for start of swath; the first hh, mm, ss, S represents the hour, minutes, seconds and 10^{th} of a second for the start of swath and the second hh, mm, ss, S represents the end time of the swath.

Execute the 'run': The following script shows an example of a command line to run the VIIRS Aerosol algorithm from the testscripts directory:

```
$  ../wrapper/Aerosol/run \
ncep_met ../testdata/input/gdas1.PGrbF00.130323.18z \
viirs.cmip ../testdata/input/IICMO_npp_d20130323_t1851552_e1853194_b07270_c20130618184731407557_noaa_ops.h5 \
viirs.gmtco ../testdata/input/GMTCO_npp_d20130323_t1851552_e1853194_b07270_c20130329144438416689_noaa_ops.h5 \
viirs.svm01 ../testdata/input/SVM01_npp_d20130323_t1851552_e1853194_b07270_c20130329144557882056_noaa_ops.h5 \
viirs.svm02 ../testdata/input/SVM02_npp_d20130323_t1851552_e1853194_b07270_c20130329144420790139_noaa_ops.h5 \
viirs.svm03 ../testdata/input/SVM03_npp_d20130323_t1851552_e1853194_b07270_c20130329144447345002_noaa_ops.h5 \
viirs.svm04 ../testdata/input/SVM04_npp_d20130323_t1851552_e1853194_b07270_c20130329144448698975_noaa_ops.h5 \
viirs.svm05 ../testdata/input/SVM05_npp_d20130323_t1851552_e1853194_b07270_c20130329144411503651_noaa_ops.h5 \
viirs.svm06 ../testdata/input/SVM06_npp_d20130323_t1851552_e1853194_b07270_c20130329144411066017_noaa_ops.h5 \
viirs.svm07 ../testdata/input/SVM07_npp_d20130323_t1851552_e1853194_b07270_c20130329144352689405_noaa_ops.h5 \
viirs.svm08 ../testdata/input/SVM08_npp_d20130323_t1851552_e1853194_b07270_c20130329144555556037_noaa_ops.h5 \
viirs.svm09 ../testdata/input/SVM09_npp_d20130323_t1851552_e1853194_b07270_c20130329144455354974_noaa_ops.h5 \
viirs.svm10 ../testdata/input/SVM10_npp_d20130323_t1851552_e1853194_b07270_c20130329144540110579_noaa_ops.h5 \
viirs.svm11 ../testdata/input/SVM11_npp_d20130323_t1851552_e1853194_b07270_c20130329144429442736_noaa_ops.h5 \
viirs.svm12 ../testdata/input/SVM12_npp_d20130323_t1851552_e1853194_b07270_c20130329144359606159_noaa_ops.h5 \
viirs.svm15 ../testdata/input/SVM15_npp_d20130323_t1851552_e1853194_b07270_c20130329144411111248_noaa_ops.h5 \
viirs.svm16 ../testdata/input/SVM16_npp_d20130323_t1851552_e1853194_b07270_c20130329144517993558_noaa_ops.h5 \
viirs.amiip ../testdata/output/IVAMI.h5 \
viirs.aot ../testdata/output/VAOOO.h5 \
viirs.aotip ../testdata/output/IVAOT.h5 \
viirs.gaero ../testdata/output/GAERO.h5 \
viirs.sum ../testdata/output/VSUMO.h5
```

A successful execution usually requires fifteen minutes or more, depending on the speed of your computer and the number of granules in 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. Either GDAS1 or GFS files may be used for the ncep_met label. Try to use a GDAS1 file that is within ±3 hours of the SDR observation time. 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 files as input, you should attempt to use a file that is within ±1.5 hours of the SDR 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. If no GDAS1 or GFS file is available using the above logic, use a GDAS1 file that is closest in time but within ±7 days of the granule time.

2. The AEROSOL_SPA will not produce the VIIRS Aerosol products if there are an insufficient number of daytime granules in the input swath.
3. The data products generated by this SPA may be visualized with the DRL's H2G_SPA (Hierarchical Data Format [HDF] to Georeferenced Tagged Image File Format [GeoTIFF] Converter Science Processing Algorithm). H2G is designed specifically for Direct Readout applications to create geolocated GeoTIFF images, jpeg browse images, and png browse images for parameter datasets in SNPP products and EOS products. H2G_SPA and its User Guide are available for download from the DRL web-portal. Please refer to Appendix A for information on enabling image production for this SPA in IPOPP.

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-vaerosol 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 Stations

Installation of this SPA in IPOPP mode will make the SPA stations listed in Table A-1 available to IPOPP. These stations along with any other pre-requisite stations (listed in Table A-2) will need to be enabled to allow IPOPP to automate production of the AEROSOL_SPA data products. Further, users who wish to generate image products from the data products generated by this SPA will need to enable the image-generating stations listed in Table A-3. The SPAs containing the pre-requisite and the image-generating stations 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 stations.

Table A-1. SPA Stations

SPA stations for this SPA	Data Products produced
Aerosol	IVAMI_npp_dyyyymmdd_thhmmssS_ehhmmssS*.h5 (Daytime Only) VAOOO_npp_dyyyymmdd_thhmmssS_ehhmmssS*.h5 (Daytime Only) IVAOT_npp_dyyyymmdd_thhmmssS_ehhmmssS*.h5 (Daytime Only) GAERO_npp_dyyyymmdd_thhmmssS_ehhmmssS*.h5 (Daytime Only) VSUMO_npp_dyyyymmdd_thhmmssS_ehhmmssS*.h5 (Daytime Only)

Table A-2. Pre-requisite Stations

Pre-requisite SPA stations	SPA in which they are available
VIIRS_C-SDR **OR** **VIIRS-SDR**	C-SDR_SPA VIIRS-SDR_SPA
CloudMask	CLOUDMASK_SPA

NOTE: The stations VIIRS-SDR and VIIRS_C-SDR must never be run simultaneously.

Table A-3. Image-generating Stations

Image-generating stations	SPA in which they are available
vaoth5d-geotiff	H2G_SPA
vapsh5d-geotiff	H2G_SPA
vsumh5d-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.