MODIS Level 2 NDVI/EVI Science Processing Algorithm

NDVIEVI_SPA

General

The NASA Goddard Space Flight Center's (GSFC) Direct Readout Laboratory (DRL), Code 606.3 developed this wrapper software for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) In-Situ Ground System (NISGS) and the International Polar Orbiter Processing Package (IPOPP).

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

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

http://directreadout.sci.gsfc.nasa.gov/index.cfm?section=contact%20us

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:

http://directreadout.sci.gsfc.nasa.gov/index.cfm?section=technology

Software Description

This DRL software package contains the Level 2 MODIS NDVIEVI_SPA. It uses all three MODIS Level 1B files (1KM, HKM and QKM) and outputs Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) in a single Hierarchical Data Format (HDF) file. MODIS NDVI/EVI is a daytime only product. The algorithm is applied on corrected reflectances in MODIS bands 1, 2 and 3. The corrected reflectance product is generated by a simple atmospheric correction program (Version 1.4.2) that corrects for molecular scattering and

gaseous absorption, but performs no aerosol correction. Other ancillary inputs include coarse resolution Digital Elevation Model (DEM) data. This is a static dataset and is included with this package. The NDVIEVI_SPA functions in two modes: Standalone, or as an IPOPP plug-in.

Software Version

Version 1 of the DRL algorithm wrapper was used to package the SPA described in this document.

Credits

The Level 2 MODIS NDVI/EVI algorithm (Version 2.2) was provided to the DRL by the MODIS Land Rapid Response Team.

Prerequisites

To run this package, you must have the Java Development Kit (JDK) or Java Runtime Engine (JRE) (Java 1.5 or higher) installed on your computer, and have the Java installation bin/ subdirectory in your PATH environment variable.

Program Inputs and Outputs

The MODIS L1B input products can be obtained from the DRL ftpsite. The datasets only cover the eastern US region.

DRL ftp site:

For Terra MODIS: ftp://is.sci.gsfc.nasa.gov/gsfcdata/terra/modis/level1/

For Aqua MODIS: ftp://is.sci.gsfc.nasa.gov/gsfcdata/aqua/modis/level1/

Datasets from other areas can be obtained either from the DAAC or from other Direct Readout stations.

Output is the MODIS Level 2 NDVI/EVI Product.

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 NDVIEVI_2.2_SPA_1.0.tar.gz and NDVIEVI_2.2_SPA_1.0_testdata.tar.gz (optional) files into the same directory. Download the CREFL_1.4.2_SPA_1.0.tar.gz if it was not previously installed on your system.

Decompress and un-archive the NDVIEVI_2.2_SPA_1.0.tar.gz and NDVIEVI_2.2_SPA_1.0_testdata.tar.gz (optional) files. Decompress and un-archive the CREFL_1.4.2_SPA.tar.gz if it was not previously installed on your system. If

CREFL_1.4.2_SPA.tar.gz was previously installed, make sure that the crefl directory is at the same level as the ndvievi directory (recommended directory structure shown below).

```
$ tar -xzf NDVIEVI_2.2_SPA_1.0.tar.gz
$ tar -xzf CREFL_1.4.2_SPA_1.0.tar.gz
$ tar -xzf NDVIEVI_2.2_SPA_1.0_testdata.tar.gz
```

This will create the following subdirectories:

```
SPA
    crefl
        algorithm
        ancillary
        station
        wrapper
    ndvievi
        algorithm
        ancillary
        station
        wrapper
        testscripts
        testdata
```

For convenience, this package contains binaries statically pre-compiled on an Intel-compatible 32-bit computer running under Fedora Core 4, using gcc 4.0.2. The binaries should work on most Linux OS/platforms. If you receive 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. Refer to the Appendix for instructions on recompiling the software.

Software Package Testing and Validation

The testscripts subdirectory contains a test script that can be used to verify that your current installation of the SPA is working properly, as described below. Note that the CREFL1.4.2_SPA_1.0.tar.gz and the optional NDVIEVI_2.2_SPA_1.0_testdata.tar.gz file are required to execute these testing procedures.

Step 1: cd into the testscripts directory.

Step 2: Run the 'run-ndvievi' script by typing: $./run-ndvievi

A successful execution usually takes some time (ranging from 5 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 a message such as:

Output modis.crefl is
/home/IPOPP/SPA/ndvievi/testscripts/MODCREF.hdf

Output modis.ndvi is
/home/IPOPP/SPA/ndvievi/testdata/output/MOD13.07053161056.hdf

You can cd to the output directory to verify that the science product really exists. If it does exist, then the wrapped SPA works perfectly. Test output product(s) are available for comparison in the testdata/output 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 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. Refer to the Appendix for instructions on recompiling the software. Please report any errors that cannot be fixed to the DRL.

Program Operation

Generating MODIS NDVI/EVI products with NDVIEVI_SPA is a two-step process. In the first step, a simple atmospheric correction algorithm is used to transform MODIS top-of-the-atmosphere Level 1B radiance data into a corrected reflectance product. Inputs to this algorithm are the MODIS L1B 1km, half km and quarter km granules from the same swath.

The corrected output is used in the second step, where the NDVI/EVI algorithm operates on it to create the MODIS NDVI/EVI Level 2 product. The output product includes the NDVI and EVI datasets.

The program may be executed using the run scripts, or by modifying the run-ndvievi script in the testscripts directory.

To Use the Run Scripts

Identify the 'run' scripts: For each of the two above steps there is a 'run' script that needs to be executed. The 'run' for the atmospheric correction algorithm can be found in the crefl/wrapper/crefl directory, while the 'run' corresponding to NDVI/EVI algorithm can be found in ndvievi/wrapper/ndvievi directory within this package. Users need to execute the 'run' within the correct wrapper subdirectory in order to execute the corresponding algorithm. The 'run' within crefl/wrapper/crefl must be first executed on the MODIS L1B products in order to create the corrected

reflectance product. This corrected reflectance product should then be used as input to execute the NDVI/EVI 'run' found in ndvievi/wrapper/ndvievi. This will create the final product. 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. 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 SPA has its own set of <label value> pairs that must be specified in order for it to execute. There are two kinds of label/value pairs that the MODIS NDVIEVI_SPA uses within the NCS framework:

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

b) 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 a list of labels, and their descriptions, that are needed by the SPA.

Reflectance Correction	
Input 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)
Output Label	**Description**
modis.crefl	Corrected Reflectance product
NDVI/EVI	
Input Label	**Description**
modis.crefl	Corrected Reflectance product
Output Label	**Description**
modis.ndvi	Output MODIS NDVI/EVI HDF product

Execute the 'runs': The following is an example of a command line to run the NDVIEVI_SPA from the ndvievi/testscripts subdirectory. You can run it from any directory of your choice, by using the correct paths to the 'run' scripts and your datasets.

```
$ ../../crefl/wrapper/crefl/run \
     modis.mxd02qkm   ../testdata/input/MOD02QKM.07053161056.hdf  \
     modis.mxd02hkm ../testdata/input/MOD02HKM.07053161056.hdf  \
     modis.mxd021km ../testdata/input/MOD021KM.07053161056.hdf \
     modis.crefl MODCREF.hdf
```

Output modis.crefl is

/home/IPOPP/SPA/ndvievi/testscripts/MODCREF.hdf

```
$ ../wrapper/ndvievi/run \
       modis.crefl MODCREF.hdf \
       modis.ndvi ../testdata/output/MOD13.07053161056.hdf
```

Output modis.ndvi is

/home/ IPOPP/SPA/ndvievi/testdata/output/MOD13.07053161056.hdf

Note that output from the first run MODCREF.hdf is used as an input to the second run. Both of them have the same label, modis.crefl. The first 'run' uses modis.crefl as an output label (identifying an output file path), while for the second 'run' it is an input label (identifying an input file path). A successful execution of 'run' usually takes some time (ranging from 5 to 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. They start with stdfile* and errfile*. 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. Refer to the Appendix for instructions on recompiling the software. The executions will create some temporary files (or symbolic links) in your execution directory. You can delete them after the run.

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 run-ndvievi script from the testscripts directory to the selected directory. Change the values of the variables WRAPPERCREFL, WRAPPERNDVI, L1HOME, and OUTPUTHOME to reflect the file paths of the wrapper directories and the input/output file paths, and then modify the input/output

file name variables. Run the script to process your data.

Appendix

Instructions for Recompiling the NDVIEVI_SPA Software

If you are going to build the binaries in this package, you will need to install the Hierarchical Data Format (HDF) library, HDF4.2rX on your system. (The DRL recommends using version HDF4.2r1.) The HDF4.2rX library can be obtained in precompiled binary form at http://hdf.ncsa.uiuc.edu. Download the library for your platform and install it. Make sure to get the JPEG, ZLIB and SZIP libraries for your platform and place all of the library and include files under the lib/ and include/ directories within the HDF install directory. You must compile both the crefl and ndvievi binaries. First cd into the SPA/crefl/algorithm directory. Modify "Makefile" to use the correct C compiler, and any additional compilation options that may be necessary. Edit the HDFHOME variable to point to the correct HDF install directory. First run "make clean" to remove any existing binaries. Next run "make" to build the binaries. Then, cd into the SPA/ndvievi/algorithm. Repeat the required changes on "Makefile" and run "make clean" and then "make".