The Automated Satellite Data Processing System

MODIS Processing

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Chapter 1. Introduction

MODIS is a MODerate resolution Imaging System on board the NASA's Terra and Aqua satellites. It is a whisk-broom type sensor that includes multiple resolutions (250m, 500m, and 1000m) and 36 bands that cover the visible, near-, short-, and long-infrared regions. This large coverage provides the simulatenous measurement of ocean color and sea surface temperatures.

MODIS Reception

MODIS is collected by the NASA.

Chapter 2. MODIS Processing

The MODIS instrument has a very similar spectral suite as other ocean color satellites (as well as other temperature data). Therefore, it is processed using the same general methods described in the ocolor color processing documentation. This chapter will only discuss the deviations from general processing specific to MODIS.

Sensor Response

The SeaWiFS instrument consists of an optical scanner and an electronics module. Below is a listing of the central wavelengths and bandwidths for SeaWiFS.

Figure 2.1.

Rayleigh/Aerosol tables

These tables are provided in the `data/modis[a,t]/rayleigh` and `data/modis[a,t]/aerosol` directories. The Rayleigh tables are given for each band. The aerosol tables are generated based on the model selections. These tables were derived by NASA.

Sensor Tables

The sensor table `data/modis[t,a]/msl12_sensor_info.dat` contains values specific to the MODIS sensor. These include the values for F0, tau_r, water absorption and backscattering terms. For MODIS, these values were generated by convolving high-spectral resolution inputs.

For the F0, the `data/common/ThuillerF0.dat` file provides the solar irradiance spectra at 1nm. The convolution of that data with the spectral respsonse provided the values given for F0 in the table in the sensor table above.

Likewise, the Rayleigh optical thickness values were generated from the `data/common/taur.txt`. The water absorption values were convolved from the `data/common/water_spectra.dat` table. And the ozone absorption coefficient values were generated from `data/common/Nickolet_o3_abs.txt`.

Atmospheric Corrections

The vicarious calibration gains and offsets for MODIS were derived from NASA.

The out-of-band correction is applied to the MODIS data. The correction was derived from NASA.

The BRDF correction used by MODIS is identical to all the other sensors processed by l2gen.

Chapter 3. Products

MODIS Top-of-Atmosphere Products

The top-of-atmosphere products include the atmospheric properties of the total radiance at the sensor. Here, *nnn* may be one of 412, 443, 469, 488, 531, 551, 555, 645, 667, 678, 748, or 869 when the input file is a MODIS 1KM input. If the input is a "high-resolution" MODIS QKM file, these additional bands are available: 1240, 1640, 2130.

Product	**Description**
Lt_*nnn*	calibrated TOA radiance at *nnn* nm
Ltir_*nnn*	calibrated TOA radiance at *nnn* nm
rhot_*nnn*	TOA reflectance at *nnn* nm
TLg_*nnn*	TOA glint radiance at *nnn* nm
glint_coeff	glint radiance normalized by solar irradiance
tLf_*nnn*	foam (white-cap) radiance at *nnn* nm
Lr_*nnn*	Rayleigh radiance at *nnn* nm
L_q_*nnn*	polarization radiance at *nnn* nm, q-component
L_u_*nnn*	polarization radiance at *nnn* nm, u-component
polcor_*nnn*	polarization correction at *nnn* nm
t_sol_*nnn*	Rayleigh-aerosol transmittance,sun to ground at *nnn* nm
t_sen_*nnn*	Rayleigh-aerosol transmittance,ground to sensor at *nnn* nm
t_oz_sol_*nnn*	ozone transmittance,sun to ground at *nnn* nm
t_oz_sen_*nnn*	ozone transmittance,ground to sensor at *nnn* nm
t_o2_*nnn*	total oxygen transmittance at *nnn* nm
t_h2o*nnn*	total water vaport transmittance at *nnn* nm
taua_*nnn*	aerosol optical depth at *nnn* nm
tau_*nnn*	same as taua_*nnn*
brdf_*nnn*	BRDF coefficient at *nnn* nm
La_*nnn*	aerosol radiance at *nnn* nm
Es_*nnn*	extra-terestrial surface irradiance at *nnn* nm
cloud_albedo	cloud albedo at 865 nm
dpol_*nnn*	transmittance at *nnn* nm
alpha	polarization rotation angle
foq_*nnn*	f/Q correction to nadir at *nnn* nm

Atmospheric Correction Products

These are derived during the atmospheric correction. Here, *nnn* may be one of 412, 443, 469, 488, 531, 551, 555, 645, 667, 678, 748, or 869 when the input file is a MODIS 1KM input. If the input is a "high-resolution" MODIS QKM file, these additional bands are available: 1240, 1640, 2130.

Product	**Description**
La_*nnn*	aerosol radiance at *nnn* nm
aerindex	aerosol index
aer_model_min	minimum bounding aerosol model #
aer_model_max	maximum bounding aerosol model #
aer_model_ratio	model mixing ratio
aer_num_iter	number of aerosol iterations, NIR correction
epsilon	retreived epsilon used for model selection
eps_78	same as epsilon
angstrom_*nnn*	aerosol angstrom coefficents (*nnn*,865) nm
eps_*nnn*_*lll*	ratio of *nnn* to *lll* single-scattering aerosol radiances
rhom_*nnn*	water + aeorsol reflectance at *nnn* nm (MUMM)

Water-leaving Products

These are derived during the atmospheric correction. Here, *nnn* may be one of 412, 443, 469, 488, 531, 551, 555, 645, 667, 678, 748, or 869 when the input file is a MODIS 1KM input. If the input is a "high-resolution" MODIS QKM file, these additional bands are available: 1240, 1640, 2130.

Product	**Description**
rrs_*nnn*	remote sensing reflectance at *nnn* nm
nLw_*nnn*	normalized water-leaving radiance at *nnn* nm
Lw_*nnn*	water-leaving radiance at *nnn* nm
rhos_*nnn*	surface reflectance at *nnn* nm

Geometery Products

These products include the viewing angles, location, and sensor information.

Product	**Description**
pixnum	pixel number
detnum	detector number
mside	mirror side
latitudes	latitudes (-90.0 to 90.0)
longitudes	longitudes (-180.0 to 180.0)
solz	solar zenith angle

Product	Description
sola	solar azimuth angle
senz	satellite zenith angle
sena	satellite azimuth angle

Ancillary Data Properties

The following are ancillary data properties used during the atmospheric correction.

Product	Description
windspeed	magnitude of wind at 10 meters
zwind	zonal wind speed at 10 meters
mwind	meridional wind speed at 10 meters
windangle	wind direction at 10 meters
water_vapor	precipital water concentration
humidity	relative humidity
pressure	barometric pressure
ozone	ozone concentration
no2_tropo	tropospheric NO2
no2_strat	stratospheric NO2

Chlorophll-a Products

Due to the configuration of band spectra (no 510 nm channel), the algorithm is a 3-band ratio as opposed to the normal 4-band algorithm of other ocean color satelittes.

Since the algorithms are general in nature, the user may modify the algorithms by defining the follow parameters for each number of band ratios. These parameters are used by **n2gen**. See the APS Ocean Color User's Guide for more information about **n2gen**.

chloc3_coeff — The coefficients for the 3-band chlorophyll-a algorithm. Defaults are [0.283,-2.753, 1.457, 0.659,-1.403].

chloc3_wave — The sensor specific wavelengths for 3-band chlorophyll-a algorithm. Defaults are [443,489,550].

Product	Description
chl_oc2	chlorophyll-a concentration using OC2 algorithm
chl_oc3	chlorophyll-a concentration using OC3 algorithm
chl_oc4	chlorophyll-a concentration using OC4 algorithm
chlor_a	chlorophyll-a concentration using OC3 algorithm
chl_stumpf	chlorophyll-a concentration using Stumpf's algorithm
chl_carder	chlorophyll-a concentration using Carder's algorithm

Diffuse Attenuation Properties

The following diffuse attenuation products are available. Here, *nnn* may be one of 412, 443, 469, 488, 531, 551, 555, 645, 667, 678.

Product	Description
Kd_532	diffuse attenuation at 532 nm using 490/555 ratio
K_length_532	diffuse attenuation at 532 nm using 443/555 ratio
Kd_*nnn*_lee	diffuse attenuation at *nnn* nm using Lee algorithm
Kd_490_morel	diffuse attenuation at 490 nm using Morel Eq8
Kd_490_morel_ok2	diffuse attenuation at 490 nm using Morel OK2
Kd_490_mueller	diffuse attenuation at 490 nm using Mueller
Kd_490_obpg	diffuse attenuation at 490 nm using OBPG
Kd_PAR_morel	diffuse attenuation (PAR) using Morel algorithm (1st optical depth)
Kd_PAR_lee	diffuse attenuation (PAR) using Lee algorithm (1st optical depth)

Euphotic Properties

The following euphotic products are available. Here *ddd* is the percent depth from 0 to 100.

Product	Description
Zeu_lee	euphotic depth, Lee algorithm
Zeu_morel	euphotic depth, Morel algorithm
Zhd_morel	Heated layer depth, Morel algorithm
Zp_*ddd*_lee	Photic depth at *ddd*, Lee algorithm
Zsd_lee	Secchi depth, Lee algorithm
Zsd_morel	Secchi depth, Morel algorithm

MODIS IOP Products

For the QAA product suite, the MODIS sensor has a 645 nm channel which is near the required 640 nm used to estimate the absorption at 555nm. The coefficients for xxx are uniquely derived.

qaa_opt — A value of 1 (the default) indicates the use of the modeled 640nm channel,

qaa_adg_s — Define the spectral slope parameter, s, to use in the QAA algorithm. Default is 0.015.

qaa_wave — The sensor specific wavelengths for QAA. For MODIS, these are defined as [412,443,488,551,-1].

Product	Description
a_*nnn*_carder	total absorption at *nnn* nm using Carder algorithm
aph_*nnn*_carder	phytoplankton absorption at *nnn* nm using Carder algorithm

Product	Description
adg_*nnn*_carder	detris/gelbstuff absorption at *nnn* nm using Carder algorithm
bb_*nnn*_carder	backscatter at *nnn* nm using Carder algorithm
b_*nnn*_carder	total scattering at *nnn* nm using Carder algorithm
c_*nnn*_carder	beam attenuation at *nnn* nm using Carder algorithm
a_*nnn*_gsm01	total absorption at *nnn* nm using GSM01 algorithm
aph_*nnn*_gsm01	phytoplankton absorption at *nnn* nm using GSM01 algorithm
adg_*nnn*_gsm01	detris/gelbstuff absorption at *nnn* nm using GSM01 algorithm
bb_*nnn*_gsm01	backscatter at *nnn* nm using GSM01 algorithm
b_*nnn*_gsm01	total scattering at *nnn* nm using GSM01 algorithm
c_*nnn*_gsm01	beam attenuation at *nnn* nm using GSM01 algorithm
a_*nnn*_qaa	total absorption at *nnn* nm using QAA algorithm
aph_*nnn*_qaa	phytoplankton absorption at *nnn* nm using QAA algorithm
adg_*nnn*_qaa	detris/gelbstuff absorption at *nnn* nm using QAA algorithm
bb_*nnn*_qaa	backscatter at *nnn* nm using QAA algorithm
b_*nnn*_qaa	total scattering at *nnn* nm using QAA algorithm
c_*nnn*_qaa	beam attenuation at *nnn* nm using QAA algorithm
flag_qaa	quality flags from QAA algorithm
mod_rrs_qaa	modeled rrs at 640 nm from QAA algorithm
c_645	beam attenuation at 645 nm using Gould algorithm
cp_645	particulate attenuation at 645 nm using Gould algorithm

Water Mass ClassificationProducts

These products are used for water mass classification. In the case of these algorithms the wavelengths available are for *nnn* are 412 or 443.

The following **n2gen** parameter controls the version of the algorithm to use for output.

wmc_version The available options are **`200702`** or **`200711`**. The default is **`200711`**.

Product	Description
wmass	water mass classification using Gould algorithm
water_mass	water mass classification image using Gould algorithm
PIM_gould	particulate inorganic matter using Gould algorithm

Product	Description
POM_gould	particulate organic matter using Gould algorithm
TSS_gould	total suspened particles using Gould algorithm
aph_412_gould	phytoplankton absorption at 412 nm using Gould algorithm
asd_412_gould	sediment and detrital absorption at 412 nm using Gould algorithm
asd_412_gould	sediment and detrital absorption at 412 nm using Gould algorithm
ag_412_gould	gelbstuff absorption at 412 nm using Gould algorithm
ap_412_gould	particulate absorption at 412 nm using Gould algorithm
as_412_gould	sediment absorption at 412 nm using Gould algorithm

MODIS Sea Surface Temperature Properties

The following land properties

Product	Description
sst	sea surface temperature
sst4	sea surface temperature (4um)
qual_sst	quality indicator of sst
qual_sst4	quality indicator of sst4

MODIS Land Properties

The following land properties

Product	Description
ndvi	normalized difference vegetation index
evi	enhanced vegetation index
smoke	smoke index
height	terrain height

Chapter 4. R_{rs} Matchup

Remote sensing reflectance, R_{rs} derived from the MODIS sensor are each compared with NRL's *in situ* data base of remote sensing reflectance measurements collected by hand-held spectroradiometer(s).

The results show that the blue region of the spectrum has the least correlation with the *in situ* reflectance data. As one moves toward the red portion of the spectrum, the data has a greater correlation. These differences can be associated with the residual reflectance (glint) in the *in situ* data and the atmospheric correction in the remote sensing data.

Remote Sensing Reflectance

The MODIS/Aqua-derived remote sensing reflectance is compared with *in situ* R_{rs} measurements processed with NRL's *in situ* data processing system.

In-situ data collection

For well over ten years, the Naval Research Laboratory collected in-situ measurements in water properties, including data from the Arabian Gulf, Mediterranean Sea, Pacific Ocean off of the Hawaiian Islands, Monterey Bay, New York Bight, and Gulf of Mexico. Due to the proximity of the Gulf of Mexico to the laboratory, the majority of the data was from this region. Since the laboratory’s emphasis was the coastal ocean, much of that in-situ data collection was in the very complex Case 2 water columns.

The Naval Research Laboratory used several instruments to derive the remote sensing reflectance. This reflectance, known as “ocean color”, related to the inherent optical products of the water column from which estimates of diver visibility and mine detection were derived. Thus, the remote sensing reflectance was a very important product to estimate and the primary focus of this matchup.

The instruments to collect this remote sensing reflectance were known as field spectrometers. The radiometers had spectrally high-resolution but very low spatial resolution since data collection was labor intensive. The collection required the personnel to obtain reads from the sky, water, and reference; usually a grey card. The collection had a rigorous protocol sequence, which included dark current, angle, and sea state as conditions considered and recorded by the personnel.

Once the data was collected, it was processed by Naval Research Laboratory software which implemented the equations of the NASA Ocean Color Protocols to derive the remote sensing reflectance. For each station, the plotted data (see Figure 1: Don't know) showed the three input targets (sky, water, reference) and the derived remote sensing reflectance. The resulting reflectance was written to a SIMBIOS formatted in-situ file and contained the time and location of collection as well as other metadata like the cruise, experiment, investigators, etc.

In-situ Data Base

After each cruise, all the in-situ data processed by Navy personnel was placed into a simple file-system data base stored under /projects/insitu. The database was organized by region, cruise, and instrument. It included data collected from other instruments and from laboratory work as well as the field spectrometers’ data. Even though some cruises did not collect spectrometer data, more than 20 gigabytes of data was gathered in this directory of over 50 cruises and data collects.

Atmospheric Correction

The basis for the atmospheric correction used by the Automated Processing System came from the work of Gordon and Wang (1994) where they proposed computing a model of the aerosol distribution by using two bands in the near infrared. Based on the “black water pixel” assumption, the reflectance from the water column was totally absorbed and, therefore, the contribution to the total signal at the sensor was zero.

However, in the coastal regime, the introduction of more constituents into the watermass caused that assumption to be invalid. The deficiency noted early in the life span of the SeaWiFS (Sea-viewing Wide Field-of-View Sensor) introduced several attempts to correct this. The best approach identified a reflectance based method which originated out of the Naval Research Laboratory. With this approach, the “black water pixel” assumption was discarded and instead, used an iterative attempt to estimate the true water reflectance. The “Near infra-red iteration” (NIR) used the relationship between the remote sensing reflectance and the inherent-optical properties of water. Furthermore, the algorithm iteratively estimated the true water contribution. Once the water contribution was known, it was removed from the NIR bands used in the Gordon/Wang aerosol prediction.

On the other hand, based on the aerosol model suite used, the Gordon/Wang atmospheric correction was unable to distinguish absorbing aerosols from non-absorbing aerosols. Thus, following the work of Rick Stump, a correction which attempted to estimate the reflectance in the blue band (412 nm) was implemented and run on each pixel. Each pixel whose Gordon/Wang derived reflectance was lower than the estimate was assumed to have been a product of an absorbing aerosol. The over compensation by the Gordon/Wang algorithm was then backed out of the remote sensing reflectance.

Match up system

To accomplish this comparison, the developers took several steps. To begin, they examined the in-situ data base for all cruises that contained field spectrometer data which was collected during the life span of each satellite. The NRL in situ data base contained data collected several years prior to the launch of the MERIS instrument. For this report, over 30 cruises were examined but only 22 used.

As each cruise was examined, the locations of each in-situ collection were entered into an ASCII file used by imgBrowse. These “points” files were placed into the match up system in data/rs/points. Once this file wascreated, the remote sensing database was examined for all scenes that were collected during that time frame. Each satellite pass was processed and four quick look browse images were created. Using these files, the satellite data was visually examined for a match.

Complete Reflectance Data base

The table below shows the number of stations for each area processed.

Cruise	Date	MODIS 1km	MODIS 250
Horn Island	May 2002	2	0
Dolche Vita	February 2003	2	0
SEED	May 2005	12	0
EPA Bold	September 2006	1	0
RV/Ocolor	February 2007	6	0
EPA	May 2007	3	0
BioSpace	October 2008	17	0

Figure 4.2. MODIS/Aqua 1KM derived R_{rs} vs *in situ* R_{rs}

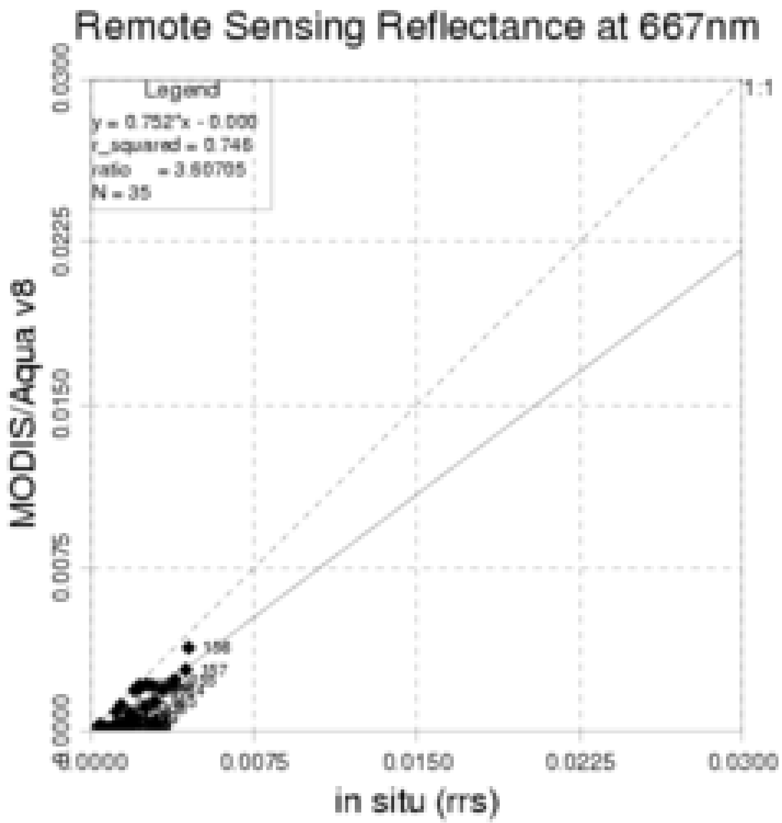
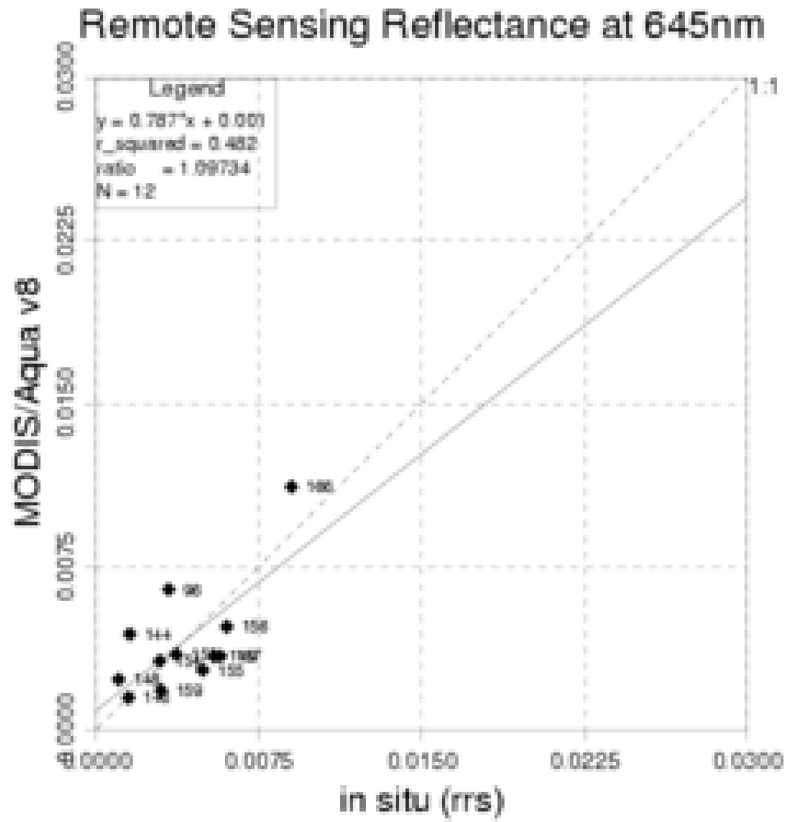


Figure 4.3. MODIS/Aqua 250m derived R_{rs} vs *in situ* R_{rs}



Chapter 5. Command Line Reference

Name

modArea — determine file extents of geographical area

Synopsis

`modArea` [-M *`mapFile`*] *`mapName`* *`inFile`*

Description

Determine the file extents (start/stop pixel/line) of a MODIS Level-1B file (still in sensor projection, etc.) that covers a map using the geolocation data in the file. It can handle the MOD03 or any of the MOD02 files.

ModArea begins by reading in the map from the mapFile. If the file can not be opened or the named map is not in the file, a diagnostic is printed and the program will exit.

Next, the input file is opened and the navigation information initialized. If unable to open the MODIS file or retrieve the navigation information from it, the program will print a diagnostic and exit.

Once the navigation has been set, **modArea** reads every point to detemine if that point falls within the desired map. From this, the smallest box that will cover the box will be determined. These file extents will be printed to the screen. If none of the latitude/longitude pairs fall in the map, then the message “No coverage” will be printed. If the file extents are the original input file, then the message will be “Complete coverage.”

In addition “No Water Coverage” is output if file does not cover any water pixels in the map.

Options

-a	Reduce data file extents by given sensor zenith angle.
-d	Debug output.
-h	Treat output (sample/lines*2) as HKM for MOD03 file.
-l	Don't output start/stop line locations.
-m percent	Set a minimum coverage that the input data must cover the region of interest. Default value is 0.
-M mapFile	Use the given map file to find mapName. Defaults to $APS_DATA/maps.hdf.
-p	Don't output start/stop pixel locations.
-q	Treat output (sample/lines*4) as QKM for MOD03 file.
-v	Make output verbose.
--help	Print out help and exit.
--version	Print out version and exit.

Environmental Variables

APS_DATA	The location of the APS data directory. Used to determine location of the default map file.

Examples

The first line shows what happens when then environment variable is not set. If not set, user must use -M to define location, unless the default file is in the current directory. The last shows the normal behavior.

```
$ modArea GulfOfMexico MOD021KM.P2003134.1140.NOAA
Map (GulfOfMexico) does not exist in file (maps.hdf).
$ modArea -M ~/aps_v3.1/data/maps.hdf GulfOfMexico MOD021KM.P2003134.1140.NOAA
unable open landmask file, not checking water coverage
No coverage
$ export APS_DATA=~/aps_v3.1/data
$ modArea GulfOfMexico MOD021KM.P2003134.1140.NOAA
No coverage
```

The next examples shows examples of regions that cover and do not cover the given regions of interest. It also shows examples of running the code on different inputs files.

```
$ modArea MissBight MOD03.A2002031.1535.003.2002034024442.hdf
No coverage
$ modArea PersianGulf MOD021KM.A2003133.0745.NOAA
747 1354 2 1157
$ modArea PersianGulf MOD03.A2003133.0745.NOAA
742 1354 1 1149
$ modArea PersianGulf MOD02HKM.A2003133.0745.NOAA
1484 2708 1 2298
$ modArea -h PersianGulf MOD03.A2003133.0745.NOAA
1484 2708 1 2298
$ modArea PersianGulf MOD02QKM.A2003133.0745.NOAA
2968 5416 1 4596
$ modArea -q PersianGulf MOD03.A2003133.0745.NOAA
2968 5416 1 4596
```

These examples show a file that is completely over land, and how changing the angle reduces the coverage of the data.

```
$ modArea PersianGulf MOD02HKM.A2003129.0805.NOAA
2350 2708 3634 4042 No Water Coverage
$ modArea ArabianSea MOD03.A2003133.0745.NOAA
678 1354 508 2030
$ modArea -a 60 ArabianSea MOD03.A2003133.0745.NOAA
678 1310 557 2030
$ modArea -a 55 ArabianSea MOD03.A2003133.0745.NOAA
678 1264 594 2030
```

As the angle is reduced, the percent coverage of the region of interest is also reduced. So, as you can see if we set a minimum amount of coverage, we eventually get “No Coverage”.

```
$ modArea -m 15 -a 55 MOD03.A2003133.0745.NOAA
678 1264 594 2030
$ modArea -m 15 -a 50 MOD03.A2003133.0745.NOAA
No coverage
```

If a problem is suspected, then use the -v (verbose) option to output more information.

```
$ modArea -v GulfOfMexico MOD03.A2002031.1535.003.2002034024442.hdf
Using Default MapFile ($APS_DATA/maps.hdf)
Initializing Map GulfOfMexico (From File /home/martinol/aps_v3.1/data/maps.hdf)
Reading Navigation Data MOD03.A2002031.1535.003.2002034024442.hdf ... done
Projecting Navigation Data to GulfOfMexico ... done
Scaning Navigation for file limits ... done
Percent Coverage/Miniumum = 0.04747047/0
limits of input file
sinpix = 1
einpix = 25
sinlin = 1
einlin = 11
limits of image map
soupix = 1872
eoupix = 2010
soulin = 1796
eoulin = 1810
size   = 2430 x 1810
1 26 1 12
Normal Completion!
```

Name

modInfo — query information about a MODIS Level-1B file

Synopsis

`modInfo` [*`option`*] *`modFile`*

Description

This program is used to dump information about a MODIS data file. With no options the program will print out a series of parameters. A single parameter can obtained using a selected option. The options are succint as they were designed with shell scripting in mind.

Options

-year	4-digit year of input file.
-doy	3-digit day of year of input file.
-month	3-character month of input file. Months are `jan', `feb', `mar', `apr', `may', `jun', `jul', `aug', `sep', `oct', `nov', `dec'
-time	6-digit time (HHMMSS) of input file.
-hour	2-digit hour (HHMMSS) of input file.
-min	2-digit min (MM) of input file.
-sec	2-digit second (SS) of input file.
-start_time	start time of input file.
-end_time	end time of input file.
-platform	Platform of MODIS file (1=Terra, 2=Aqua)
-version	Major component of PGE version of file.
--version	Print out version and exit.

Examples

```
$ modInfo MOD021KM.A2001337.0340.003.2001339033031.hdf
Filename:        MOD021KM.A2001337.0340.003.2001339033031.hdf
Starting Time:   12/03/2001 03:40, 337
Ending Time:     12/03/2001 03:45, 337
$ modInfo -year MOD021KM.A2001337.0340.003.2001339033031.hdf
2002
$
```

Here is how a Bourne shell script function might use **modInfo** to set the name of the output files from the input file:

```
set_name()
{
    yr=`modInfo -year $1`
    jday=`modInfo -doy $1`
    time=`modInfo -time $1`
    file=MODAM$yr$jday$time.L1A
}
```

Name

mod_L1A_to_L1B.csh — convert MODIS L1A (uncalibrated) data to L1B (calibrated) data

Synopsis

`mod_L1A_to_L1B.csh` *`L1A_file`* *`GEO_file`*

Description

The modis_L1A_to_L1B.csh wrapper script creates 3 MODIS formatted Aqua or Terra Level 1B files of 1km, 500m, and 250m resolution. It requires a MODIS formatted Level 1A file and its corresponding Geolocation file as input. If no output L1B filename is specified, the filename will be constructed using the AYYYYDDDHHMMSS or TYYYYDDDHHMMSS prefix format where YYYYDDDHHMMSS is the calculated pass start time. The Level 1B filenames will be given ".L1B_LAC", ".L1B_HKM", and ".L1B_QKM" suffixes for the 1km, 500m, and 250m resolutions respectively. A default Level 1B file output directory can be defined by setting the MODIS_L1B environment variable.

If the calibration LUTs are not specified on the command line, the LUTs defined by the following environment variables will be used during L1B processing:

- AQUA_REFL_LUT
- AQUA_EMIS_LUT
- AQUA_QA_LUT
- TERRA_REFL_LUT
- TERRA_EMIS_LUT
- TERRA_QA_LUT

The default location of the calibration LUTs is in $APS_VAR_DATA/modisa/cal/ and $APS_VAR_DATA/modist/cal/. It is MANDATORY that all three LUTS (reflective, emissive, and qa) reside in the same directory.

Options

-b	Use the base of the input L1A filename (up to first ".") for naming the output filenames. This allows for filename bases to now be kept identical through the processing chain instead of the seconds potentially changing.
-o	Output filename for the 1km resolution L1B file..
-h	Output filename for the 500m resolution L1B file.
-q	Output filename for the 250m resolution L1B file.
-rlut REFL_LUT_filepath	User-specified Reflective LUT file to be used in L1B processing. All three LUTS (reflective, emissive, and qa) MUST reside in the same directory.
-elut EMIS_LUT_filepath	User-specified Emissive LUT file to be used in L1B processing. All three LUTS (reflective, emissive, and qa) MUST reside in the same directory.

-qlut QA_LUT_filepath	User-specified QA LUT file to be used in L1B processing. All three LUTS (reflective, emissive, and qa) MUST reside in the same directory.
-delete-1km	Delete the 1km resolution L1B file.
-delete-hkm	Delete the 500m resolution L1B file.
-delete-qkm	Delete the 250m resolution L1B file.
-save-log	Save the Level 1B processing LogStatus file. (All logs are deleted by default if processing completes without a fatal error.)

Environmental Variables

APS_DIR	The location of the APS directory.
APS_BIN	The location of the APS binary directory. Used to determine location of the default l1bgen program.
APS_VAR_DATA	The location of the APS variable data directory. Used to determine location of the LUTs.
APS_DATA	The location of the APS data directory. Used to determine location of the default map file.

Examples

The next examples show examples of using the script to create a Terra day-time pass and an Aqua night-time pass.

Example 5.1. MODIS/Terra L1A to L1B calibration

```
$ mod_L1A_to_L1B.csh GulfOfMexico MOD021KM.P2003134.1140.NOAA
```

Example 5.2. MODIS/Aqua L1A to L1B calibration

```
$ mod_L1A_to_L1B.csh GulfOfMexico MOD021KM.P2003134.1140.NOAA
```