The Automated Satellite Data Processing System

OCM Processing

The Automated Satellite Data Processing System: OCM Processing

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Chapter 1. Introduction

The Ocean Color Monitor (OCM) is a space-borne sensor embarked on the Indian satellite IRS-P4 (now called Oceansat-1). The OCM is a solid state camera operating in eight narrow spectral bands which match the spectral suite of SeaWiFS. The push-broom imaging sensor has a field of view of 360m and total swath coverage of 1420 km. To avoid sun glint, the OCM has the ability to tilt 20 degrees. It has a 12-bit radiometric precision to handle a large dynamic range needed to the sensitivies of land and water.

OCM Reception

Data from the Ocean Color Monitor is downlinked directly from the satellite via an X-band transmission. A TeraScan X-band antenna and software suite handles the daily capture of data. The TeraScan software is then used to perform the calibration of the sensor and provide navigation. Solar and satellite zenith/azimuth angles are appened to the file. The output is finally convert to an Hierarchical Data Format (HDFv4).

A TeraScan script is provided in the `share/terascan` directory to accomplish the above tasks. It can output data as either calibrated radiances (default) or uncalibrated counts. It will attempt to automatically correct for navigation errors.

The TeraScan program ocmcal preforms the calibration according to IRSO specifications as outlined in the document: *Radiometric Normalization for IRS-P4: OCM*, A. Senthil Kumar, OCM-Data Products Team Signal and Image Processing Group, Space Applications Center, Ahmedabad, India.

Chapter 2. Processing

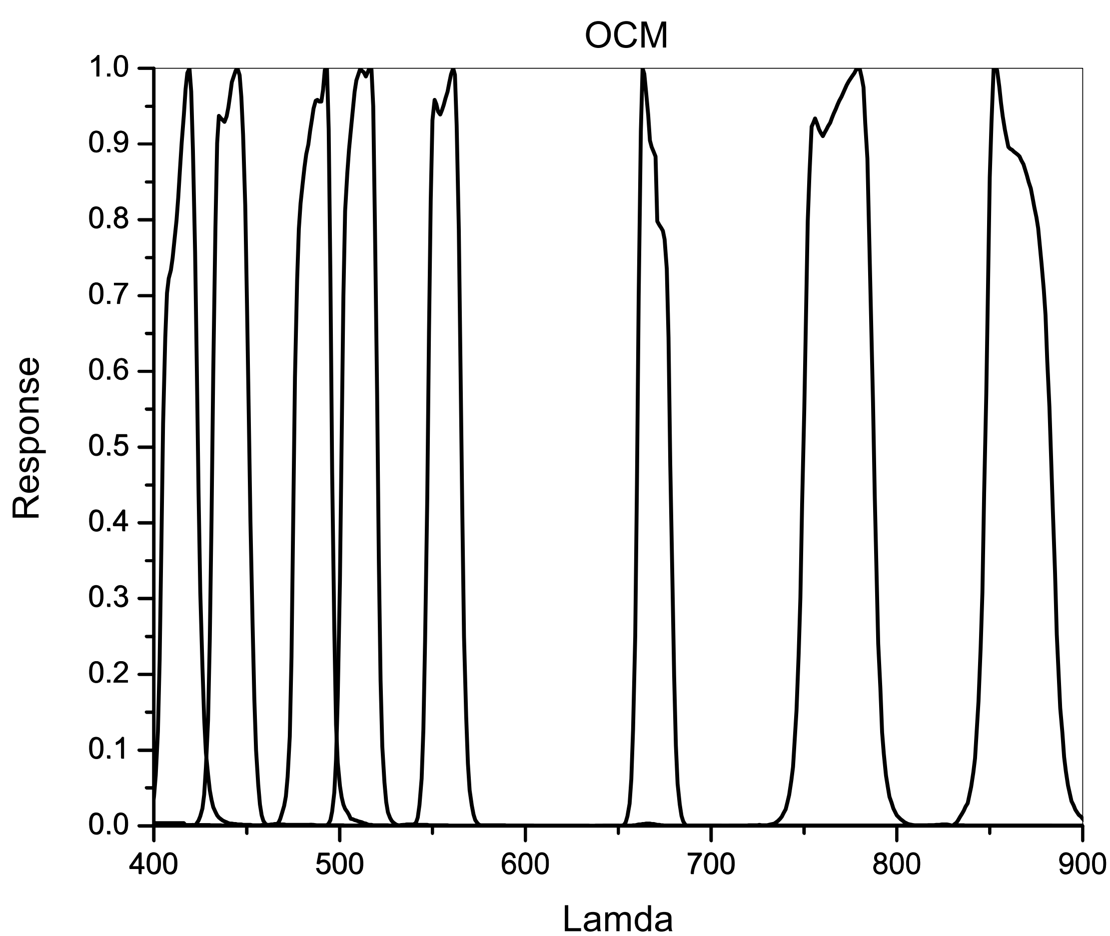
The Ocean Color Monitor (OCM) data is processed with the main ocean color process program l2gen. The general documentation on ocean color data processing is located in that reference. Here, only the specifics of the OCM data are discussed. In particular, the OCM data exhibits a large variation in inter-detector calibration. This is manifested in the stripes seen in the imagery. A techique to correct this is discussed in the next section.

OCM De-striping

Sensor Response

The OCM instrument spectral response is given below. The widths and locations of the band-passes are very similar to the SeaWiFS sensor. However, using the IOCCG band centers, the two sensors differ by one of two nanometers in all bands.

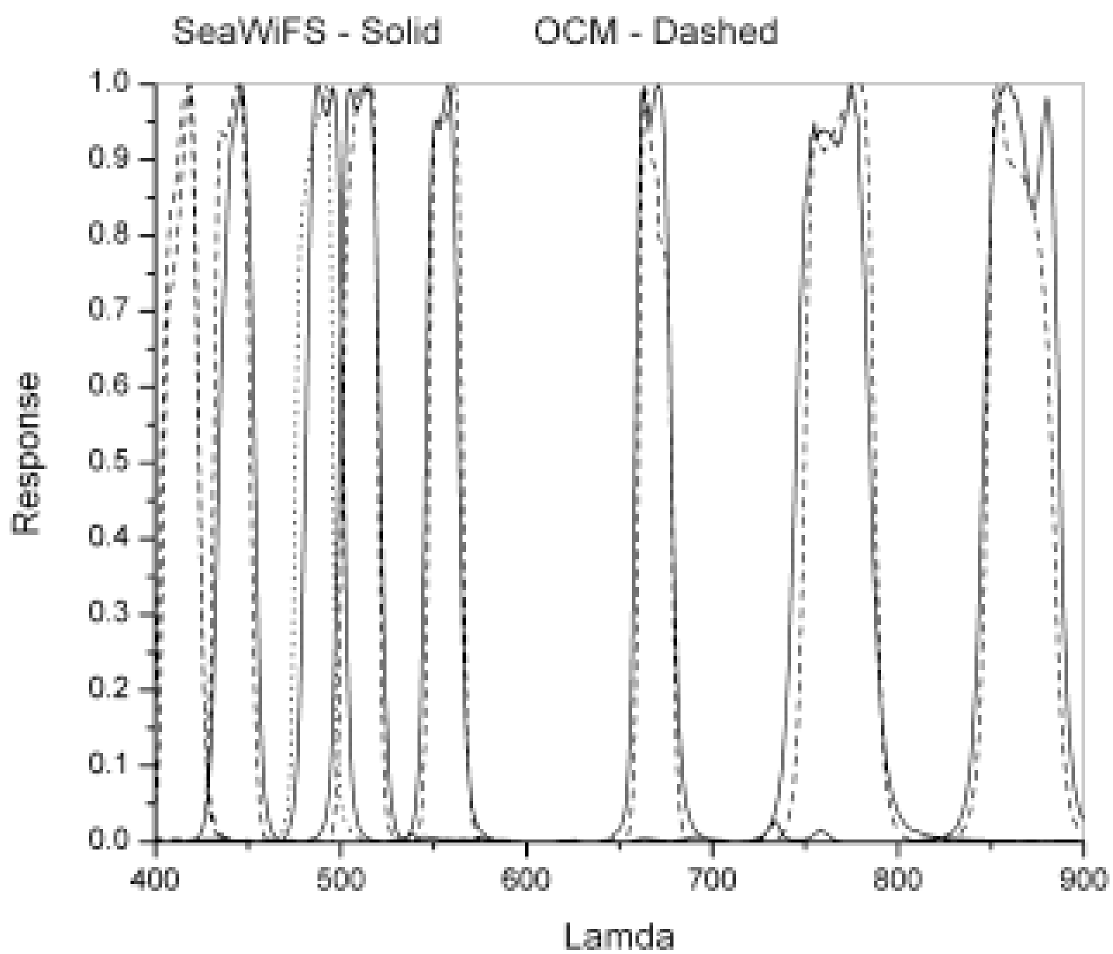
Figure 2.1.



Rayleigh/Aerosol tables

Given the similarity between the spectral response of the OCM channels and the SeaWiFS, the SeaWiFS Rayleigh and aerosol tables are used as the OCM Rayleigh and aerosol tables. Some time in the future, it is hoped that more robust tables can be generated.

Figure 2.2.



These tables are provided in the `data/ocm/rayleigh` and `data/ocm/aerosol` directories. The Rayleigh tables are given for each band. The aerosol tables are generated based on the model selections.

Sensor Tables

The sensor table `data/ocm/msl12_sensor_info.dat` contains values specific to the OCM sensor. These include the values for F0, tau_r, water absorption and backscattering terms. For OCM, 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 OCM are defined as 1.0. That is, no vicarious calibration is performed on OCM.

No out-of-band correction is applied to the OCM data.

The short infra-red band on OCM falls in the same range of SeaWiFS and, therefore, is effected by the O2 absorption at 762nm. The effect and correction for SeaWiFS and OCTS was presented by xxx and Gordon (1997). The l2gen software applies that correction to both sensors. For OCM, the correction is also applied. This correction is controlled by the l2gen parameter oxaband_opt.

The white cap coefficients used by OCM are identical to those of SeaWiFS.

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

Chapter 3. Products

OCM Top-of-Atmosphere Products

The OCM Top-of-Atmosphere products include the atmospheric properties of the total radiance at the sensor.

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 transmit- tance,ground to sensor at *nnn* nm
t_oz_sol_*nnn*	ozone transmittance,sun to ground at *nnn* nm
t_oz_sen_*nnn*	ozone transmit- tance,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

OCM Atmospheric Correction Products

Geometery Products

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)

OCM Water Products

Geometery Products

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

OCM Geometery Products

Geometery Products

Product	Description
pixnum	pixel number
detnum	detector number
latitudes	latitudes (-90.0 to 90.0)
longitudes	longitudes (-180.0 to 180.0)
solz	solar zenith angle
sola	solar azimuth angle
senz	satellite zenith angle
sena	satellite azimuth angle

OCM Ancillary Data Properties

The following apparent optical properties

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

OCM Chlorophll-a Products

The chlorophyll-a product for OCM uses the same general formula for chlorophyll-a calculations. However, 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.

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 sensor-specific default
chl_stumpf	chlorophyll-a concentration using Stumpf's algorithm
chl_carder	chlorophyll-a concentration using Carder's algorithm

OCM Apparent Optical Properties

The following apparent optical properties

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)

OCM IOP Products

For the QAA product suite, the available wavelengths *nnn* are 414, 442, 489, 512, 557, and 670.

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 OCM, these are defined as [414,442,488,557,-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
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

OCM Water Mass Classification Products

These products are used for water mass classification. In the case of these algorithms the wavelengths available are for *nnn* are 414 or 442.

wmass	water mass classification using Gould algorithm
water_mass	water mass classification image using Gould algorithm
PIM_gould	particulate inorganic matter using Gould algorithm
POM_gould	particulate organic matter using Gould algorithm
TSS_gould	total suspened particles using Gould algorithm
aph_*nnn*_gould	phytoplankton absorption at *nnn* nm using Gould algorithm
asd_*nnn*_gould	sediment and detrital absorption at *nnn* nm using Gould algorithm
asd_*nnn*_gould	sediment and detrital absorption at *nnn* nm using Gould algorithm
ag_*nnn*_gould	gelbstuff absorption at *nnn* nm using Gould algorithm
ap_*nnn*_gould	particulate absorption at *nnn* nm using Gould algorithm
as_*nnn*_gould	sediment absorption at *nnn* nm using Gould algorithm

Name

ocmArea -- determines the file extents of an NRL OCM Level-1B data file which covers an image map.

ocmArea
`ocmArea [options] mapname filename`

Description

Determines the file extents (start/stop pixel/line) of an NRL OCM Level-1B file (still in sensor projection) that covers a map.

The command **ocmArea** 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 OCM file is opened and the navigation information initialized. If unable to open the file or get the navigation information from the file, the program will print a diagnostic and exit.

Once the navigation has been set, **ocmArea** reads in every scan line and determines the latitude and longitude for 1597 pixels over the entire scan line (or approximately every 6th pixel). For each point that falls within the desired maps, the starting and stopping sample (or column) number of the file is determined. The line extents are also determined by the first line that contains data that falls within the box and the last line that falls outside the box again. The file extents are adjusted to be slightly larger than those found by the above procedure to ensure that no data within the region is missed. These file extents will be printed to the screen. These are printed to stdout: starting pixel, space, ending pixel, space, starting line, space, ending line.

If the entire file covers the image map, then "Complete coverage" will be written to stdout. If no part of the file covers the image map, then "No coverage" will be written to stdout.

Based on the landmask, **ocmArea** can also determine if any pixels within the region fell over water. If not samples fell over water then the message "No Water Coverage" is added. This can be used to determine if the file is to be processed even when it covers the interested area.

Options

-a angle

if *angle* is defined then it is used to reduce the swath of the input image. It will reduce the image during calculation of file extents. It can be used to prevent the large pixels from the edge of the swath to be output. If angle is less than 1.1, then it is assumed to be given in radians. Otherwise it is give in degrees. A negative angle will be converted to a positive one.

-l

Don’t output start/stop line locations

-L file

Use file as the input land mask file. Defaults to `$APS_DATA/landmask.dat`

-M mapFile

Use the given map file to find mapName. Defaults to `$APS_DATA/maps.hdf`

-p
Don’t output start/stop pixel locations

-v
Verbose output

--help
Display program help.

--version
Display program name version and time of compilation.

Environmental Variables

APS_DATA
The location of the APS data directory.

Examples

The examples below show the same input file run against two different geographical areas. The last examples shows the result of trying to use an invalid input.

Example 1. Use of ocmArea

```
$ ocmArea GulfOfMexico OS1.2007308.1755.L1_HNAV
1 3736 864 6908
$ ocmArea -p -M my_maps.hdf GulfOfMexico OS1.2007308.1755.L1_HNAV
864 6908
$ ocmArea EastSea OS1.2007308.1755.L1_HNAV
No coverage
$ ocmArea -M ../etc/maps.hdf Junk OS1.2007308.1755.L1_HNAV
-E- map Junk not found in file ../etc/maps.hdf
Aborted
$ echo $?
134
```

Name

ocmInfo -- queries information about an OCM Level-1B file(s).

ocmInfo
`ocmInfo` *`file1 file2 file3 .. ..`*
`ocmInfo` *`option file`*

Description

Run without options, **ocmInfo** will write a report for each input file indicating satellite id, data type, etc. It may also be run with a single option and print the input file(s) value for that option. The first method is intended for interactive use at the shell prompt and the second method is intended for use within a shell program.

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.

-type
: 1-digit code for datatype, where: 1=LAC, 2=GAC, 3=HRPT

-sat
: 3-character satellite name. Names are ‘t-n’, ‘n06’, ‘n07’, ‘n08’, ‘n09’, ‘n10’, ‘n11’, ‘n12’, ‘n14’, ‘n15’, or ‘n16’.

-sat_code

3-character satellite name. Names are ‘TN’, ‘NA’, ‘NC’, ‘NE’, ‘NF’, ‘NG’, ‘ND’, ‘NJ’, ‘NK’, or ‘NL’.

-name

Generate a file name in the following format as SSS.YYYY.MMDD.HHMM.T, where T is ‘l’ for LAC, ‘h’ is for HRPT and ‘g’ is for GAC.

--help

Display program help.

--version

Display program name version and time of compilation.

Examples

Here is how a Bourne shell script function might use **ocmInfo** to set the name of the output filenames:

Example 2. Use of ocmInfo within shell

```
set_name()
{
   sat=‘ocmInfo -sat $1‘
   yr=‘ocmInfo -year $1‘
   jday=‘ocmInfo -doy $1‘
   time=‘ocmInfo -time $1‘
   file=$sat.$yr$jday.$time.l1b
}
```

Here is an interactive use of **ocmInfo**:

Example 3. Interactive use of ocmInfo

```
$ ocmInfo OS1.2007308.1755.L1_HNAV
Filename:      OS1.2007308.1755.L1_HNAV
Starting Time:  11/04/2007 17:55, 308
Ending Time:    unknown
Satellite:     oceansat-1
File Type:     OCM Level-1B
Total Scans:    9678
Total Samples:  3740
```