SAC/SIPA/DPSG/OCM-2/Level-2 HDF/2009/FEB/1

OCM-2 (OCEANSAT-2)
LEVEL-2 HDF Data Products Format

Ver. 1.4, APR. 2017

Data Products Software Group
Space Applications Centre, ISRO
Ahmedabad

Document Control and Data Sheet

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Authors	Vivek Sharma,Nitant Dube, Sazid Mahammad
Originating Unit	Data Products Software Group SIPA/SAC, Ahmedabad
Abstract	This documents brings out the LEVEL-2 HDF Data Products Format for OCM-2.
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Approved By

(Dr. R. Ramakrishnan)
Group Director
Data Products Software Group
SIPA/SAC, Ahmedabad-15

Version Change History

***C:Creation,** A:Addition, M: Modification,D:Deletion

Version No	Date	Section Number	*A/M/D	Remark
V 1.0	FEB2009	New	C	Newly Created
V 1.1	16AUG2010	5.1.8 L2 Flag Data Group	A	L2 Flag Data
V 1.2	08MAR2016	5.1.8 L2 Flag Data Group	M	Changes in L2 Flag Data Interpretation
V 1.3	15-MAR-2017	5.1.9 Geophysical Data Set Attributes APPENDIX-E Variation of Sun Zenith Angle Variation across latitudes across year	M	Addition of Geophysical Dataset attributes and table showing variation of Sun Zenith Angle across latitude throughout the year
V1.4	17-APR-2017	APPENDIX-F Effect of Solar Zenith Angle over Water Leaving Radiance Retrieval	M	Addition of Description of effect of solar zenith angle over water leaving radiance retrieval

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1.0 Introduction

Oceansat-II OCM data products are generated in HDF-4. HDF is the hierarchical representation of one or more data sets be it Meta Data or Image Data enabling quick access and efficient storage. In short it is a multi object file format for sharing scientific data in a distributed environment. It is basically meant for data sets that are large and need to be platform independent. This document gives details of OCM-2 LEVEL-2 digital data products.

HDF files are self-describing which means that for each HDF data structure in a file, there is comprehensive information about the data (data type dimension, etc.) and its location in the file. By using appropriate data structures it is possible to store symbolic, numerical and graphical data within HDF file. HDF can be viewed as several interactive levels. At its lowest level, HDF is a physical file format for storage of scientific data. At its highest level, it is a collection of utilities and applications for manipulating, viewing and analyzing data stored in HDF files.

2.0 Oceansat-2 Product in HDF 4.0

Both LAC (Local Area Coverage) Products (Radiance, Geo-referenced and Geo-physical parameters) and GAC (Global Area Coverage) Products (Radiance and Geo-physical parameters) are generated in HDF format.

2.1 HDF Product File Naming Convention

2.1.1 User Requested Media Products

The user requested product will be provided in requested media with following directory structure. Each media product will contain following files/directories.

CDINFO : ASCII file containing details of contents of Media
PRODUCT1/JobId.hdf : HDF4 data products
PRODUCT1/JobId.jpg : JPEG Chip of Product
PRODUCT1/JobId.meta : ASCII Product Metadata

The JobId is 12 character Product Identification.

2.1.2 Archived Products

Following are the product file naming convention:

File Name =SS_DDMMMYYYY_PPP_RRR_CCX_LPP_TT_D.hdf

Where
SS = Satellite Name

= O2 for OCEANSAT-2.

DDMMMYYYY= Date of acquisition

PPP = Path

RRR=Row

CC = Area Coverage

= LA for Local area Coverage

= GA for Global Area Coverage

X = P for Payload (valid for LAC)
D for SSR day (valid for LAC and GAC)
N for SSR night (valid for LAC an GAC)

LPP = Processing Level

= L2B (Geo Physical Parameter Product)

= L2C GR (Geo-referenced product for any Geo Physical Parameter Product)

TT = Product Name Mnemonics

= CL for Chlorophyll Product

= AO for Aerosol Depth Product

= DA for Different Attenuation Product

= SE for Total Suspended Sediments Product

D = The Flag Indicating Single Scene or Period of Binned Data.
= S For Single Scene
= W For Weekly Binned
= M For Monthly Binned
= Y For Yearly Binned

For example Oceansat-2 L2B LAC Chlorophyll product of 10 DEC 2006, of Path/Row 100/60 will have name

O2_10DEC2007_100_060_LAC_L2B_CL_S.hdf

3.0 Contents of Oceansat-2 Product in HDF

There are Scientific Data Sets in Oceansat data products that are used for storing and retrieving different types of image information and a fixed number of VGroups under which these Data Sets are arranged. An Oceansat Product generated in HDF4.0 format has the very first virtual Group as the File itself containing the Global information for the Product. It contains parameters used for describing the product type and its associated information like Product Name, Generation software, Generation Time, Station Name and Location, Mission characteristics, Sensor characteristics and product Title, Time information of the product, other Product specifications, and complete scene information. All character fields are left aligned.

OCEANSAT-2 supports LEVEL-2B/2C Products in HDF4 format. There is no L2C product for GAC mode of operations. All Level-2C products are Geo-referenced , aligned to true north.

3.1 Contents of LEVEL-2A (Raw) Product

There is no Level2A product in OCM-2

3.2 Contents of LEVEL-2B (Radiance) Product

Following groups are present in LEVEL-2B product:

- HDFFilename Group (containing Global attributes)
- Scan Line Attributes
- Geophysical Data L2B Data for Geo physical parameter
- Navigation Group

3.3 Contents of LEVEL-2C (Geo-referenced) Products

There is no Level 2C product for GAC Operational Mode. This is valid only for LAC mode.

- HDFFilename Group (containing Global attributes)
- Geophysical Data (Georeferenced Radiance Data for given geo physical parameter)
- Map Projection Group

4.0 Brief Description of HDF Product Groups

4.1 HDFFilename Group

This group is a global group named as the actual HDF filename and stores the global attributes giving details of Satellite Name, Product Type, name, generating station/agency, date and time of processing, scene corner co-ordinate etc.. This contains basically administrative information required by the processing software.

4.2 Scan Line Attributes

This group contains auxiliary data for each scan line including the start time for each line of imaging, engineering quality flags, latitude and longitude of the center pixel of each scan line, satellite vectors and tilt information for the entire product.

4.3 Geophysical Data

This group contains actual Radiance data for each band in case of LEVEL-2B/2C products for actual Geophysical value (e.g. chlorophyll concentration). Kindly refer to the APPENDIX-F and E for effect of solar zenith variation on water leaving radiance retrieval.

4.4 Navigation Group

This group has satellite parameters at the time of imaging that includes velocity vector, orbital position vector, Roll, Pitch Yaw information, sun reference angles for the product.

4.5 Map Projection Group

This group provides details of datum, ellipsoid and map projection parameters for geo-referenced products.
This group is valid for Level-2C (Geo-referenced products). The details of map projection parameters are given in APPENDIX-A,B and C.

5.0 Detailed Contents of Various Groups of Level-2 HDF Product

Following section gives detailed fields present in various groups of OCM-2 products.

5.1 Groups present in Level-2 Products

The Table –2 gives the various groups present in a LEVEL-2 Product.

Group Name	**Table to Refer**	**Valid Levels**	**Remarks**
<File Name>	Table-2	L2B, L2C	Global Attributes
Scan Line Attributes	Table-3	L2B	Scan Details
Geophysical Data	Table-4	L2B, L2C	Image Data
Navigation	Table-5	L2B	Navigation Info
Map Projection Group	Table-6	L2C	Map Projection Parameters for L1C products
L2 Flag Data Group	Table-7	L2B, L2C	L2 Flag Data

Table-1: Various Groups present in Level 1 HDF formatted Products

5.1.1 <FileName> group (Global Attributes)

5.1.1.1 Mission and Documentation

Attribute Name	Data Type	Value/Remark
Product Name	Character	The name of the product file (without path)
Title	Character	"Oceansat OCM2 Level-2B Data" Here Level depends on 2B/2C product
Data Center	Character	ISRO/NRSC
Station Name	Character	Hyderabad
Mission	Character	Oceansat-2
Mission Characteristics	Character	"Nominal orbit: inclination = 98.28 (Sun-synchronous); node = 12 noon local (descending); eccentricity = <0.002; altitude = 720 km; ground speed = 6.7818 km/sec".
Sensor	Character	"Ocean Color Monitor OCM-2".
Sensor Characteristics	Character	"Number of bands =8; number of active bands = 8; central wavelengths per band (nm) = 412, 443, 490, 510, 555, 620, 740, 865; bandwidth per band 20, 20, 20, 20, 20,20, 30, 40; bits per pixel = 12; instantaneous field –of-view = 1.5835 mrad; pixel per scan = 3730; scan rate = 28.78/sec; sample rate = 190215.8/sec". Note: Pixel per scan, scan rate and sample rate are given for the sensor; effective rates for GAC data are lower due to subsampling.
Data Type	Character	"GAC ", "LAC "
Replacement Flag	Character	"ORIGINAL"
Software ID	Character	Identifies version of the operational software used to create this product. Default value is "I "
Processing Time	Character	Local time id generation of this product; concatenated digits for year, day-of-year, hour, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF as given in work order file.

5.1.1.2 Data Time

Attribute Name	Data Type/Dimension	Value/Remark
Start Time	Character	Start GMT of the first scan of the scene; concatenated digits for year, day-of-year, hours, minutes, seconds and fraction of seconds in the format of YYYYDDDHHMMSSFFF.
End Time	Character	Start GMT of the last scan line of the scene; concatenated digits for year, day-of-year, hours, minutes, seconds and fraction of seconds in the format of YYYYDDDHHMMSSFFF.
Scene Center Time	Character	Start GMT of the center scan line of the scene; concatenated digits for year, day-of-year, hours, minutes, seconds and fraction of seconds in the format of YYYYDDDHHMMSSFFF.
Start Year	2-byte integer	GMT year of first scan line of the scene.
Start Day	2-byte integer	GMT day-of-year of first scan line of the scene.
Start Millisec	4-byte integer	GMT milliseconds-of-day of the first scan line of the scene.
End Year	2-byte integer	GMT year of last scan line of the scene.
End Day	2-byte integer	GMT day-of-year of last scan line of the scene.
End Millisec	4-byte integer	GMT milliseconds-of-day of the last scan line of the scene.
Start Node	Character	“Ascending” or “Descending”; describe node direction at the start of the scene.
End Node	Character	“Ascending” or “Descending”; describe node direction at the start of the scene.
Orbit Number	4-byte integer	Orbit number of the scene.

5.1.1.3 Data Characteristics

Attribute Name	Data Type/Dimension	Value/Remark
Pixels per Scan Line	4-byte integer	1243 if Data type – “GAC”, else, 3730
Number of Scan Lines	4-byte integer	Number of scan lines in the scene.

LAC Pixel Start Number	4-byte integer	The LAC pixel number corresponding to the first pixel in scan lines of this product; 3 if Data Type – "GAC", else 1.
LAC Pixel Subsampling	4-byte integer	The subsampling rate for the pixel in this product relative to LAC scan lines; 3 if Data Type = "GAC",else 1
Scene Center Scan Line	4-byte integer	Number of the center scan line (1-relative) of the scene, relative to first scan line.

5.1.1.4 Scene Coordinates

Attribute Name	**Data Type**	**Value/Remark**
Latitude Units	Character	"degrees", unit used for all latitude values in this product
Longitude Units	Character	"degrees", unit used for all longitude values in this product
Scene Center Latitude	4-byte real	Latitude of the nadir point of the scene's center scan line.
Scene Center Longitude	4-byte real	Longitude of the nadir point of the scene's center scan line.
Scene Center Solar Zenith	4-byte real	Solar zenith angle of the nadir point of the scene's center scan line.
Upper Left Latitude	4-byte real	Latitude of the upper left scene corner.
Upper left Longitude	4-byte real	Longitude of the upper left scene corner.
Upper Right Latitude	4-byte real	Latitude of the upper right scene corner.
Upper Right Longitude	4-byte real	Longitude of the upper right scene corner.
Lower Left Latitude	4-byte real	Latitude of the lower left scene corner.
Lower Left Longitude	4-byte real	Longitude of the lower left scene corner.
Lower Right Latitude	4-byte real	Latitude of the lower right scene corner.
Lower Right Longitude	4-byte real	Longitude of the lower right scene corner.
Northernmost Latitude	4-byte real	Northernmost latitude of all scan line end points.
Southernmost Latitude	4-byte real	Southernmost latitude of all scan line end points.
Westernmost Longitude	4-byte real	Westernmost Longitude of all scan line end points.
Easternmost Longitude	4-byte real	Easternmost Longitude of all scan line end points.
Start Center Latitude	4-byte real	Latitude of center pixel for first scan

		line.
Start Center Longitude	4-byte real	Longitude of center pixel for first scan line.
End Center Latitude	4-byte real	Latitude of center pixel for last scan line.
End Center Longitude	4-byte real	Longitude of center pixel for last scan line.
Product Type	Character	Product Type such as CHLOROPHYLL PRODUCT, AEROSOL OPTICAL DEPTH PRODUCT, SUSPENDED SEDIMENTS PRODUCT , DIFFUSED ATTENUATION PRODUCT
Path	4-byte integer	Path of acquisition
Row	4-byte integer	Row of acquisition
Product Level	Character	L2B/L2C
Pass Type	Character	SSRD (for SSR Day) SSRN (for SSR Night) PLD Real Time
Integration Time	4-byte real	Integration time in milliseconds
Attitude Source	Character	
Orbit Source	Character	
ADIF Scene Center Roll	4-byte real	Scene Centre Roll given by ADIF
ADIF Scene Center Pitch	4-byte real	Scene Centre Pitch given by ADIF
ADIF Scene Center Yaw	4-byte real	Scene Centre Yaw given by ADIF
ADIF Regeneration Counter	2 byte integer	Regeneration counter of ADIF
Across Track Resolution	4-byte real	Resolution along track
Along Track Resolution	4-byte real	Resolution across track
Saturation Radiance Band1	4-byte real	Saturation Radiance for Band-1
Saturation Radiance Band2	4-byte real	Saturation Radiance for Band-2
Saturation Radiance Band3	4-byte real	Saturation Radiance for Band-3
Saturation Radiance Band4	4-byte real	Saturation Radiance for Band-4
Saturation Radiance Band5	4-byte real	Saturation Radiance for Band-5
Saturation Radiance Band6	4-byte real	Saturation Radiance for Band-6
Saturation Radiance Band7	4-byte real	Saturation Radiance for Band-7
Saturation Radiance Band8	4-byte real	Saturation Radiance for Band-8
Tilt	4-byte real	Tilt value valid for the pass
Sun Elevation Angle	4-byte real	Sun Elevation angle in degrees
Sun Azimuth Angle	4-byte real	Sun Azimuth angle in degrees
Sat Elevation Angle	4-byte real	Satellite Elevation angle in degrees
Sat Azimuth Angle	4-byte real	Satellite Azimuth angle in degrees
Sat Altitude	4-byte real	Actual Satellite Altitude in Km.
Datum	Character	Datum Used e.g WGS-84 ,IND-I

Band Temperatures	Character	Temp Band1, Temp Band2, …. Temp Band8
Band Exposures	Character	Exposure Band1, Exposure Band2, ……. Exposure Band8
DQERollBias	4-byte real	Roll Bias (in degrees) used for generation of Product
DQEPitchBias	4-byte real	Pitch Bias (in degrees) used for generation of Product
DQEYawBias	4-byte real	Yaw Bias (in degrees) used for generation of Product
Sun_Zenith_Threshold	4-byte real	This attribute is available only in L2B products. The High Sun Zenith Flag (Bit-5) in the "l2_flags" dataset in "L2 Flag Data" group is set based on this value. All the pixels having Sun Zenith above this value will have Sun Zenith Flag (Bit-5) set.

Table-2: Details of <Filename> group

5.1.4 Scan-Line Attributes group

No	SDS Name	Data Type	Array Size	Value	Remarks
01	year	32 bit int	1 x Scans	2006	Year of scan for every scan line
02	day	32 bit int	1 x Scans	105	Day of scan for every scan line
03	msec	32 bit int	1 x Scans	29455209	Milli-sec for each scan line
04	slon	32 bit float	1 x Scans		Longitude of start pixel
05	clon	32 bit float	1 x Scans		Longitude of center pixel
06	elon	32 bit float	1 x Scans		Longitude of end pixel
07	slat	32 bit float	1 x Scans		Latitude of start pixel
08	clat	32 bit float	1 x Scans		Latitude of center pixel
09	elat	32 bit float	1 x Scans		Latitude of end pixel
10	csol_z	32 bit float	1 x Scans		Scan center-pixel solar zenith angle

Table-3: Details of Scan-Line group

5.1.5 Geophysical Data group

No	SDS Name	Data Type	Array Size	Value	Remarks
01	clo	32 bit float	Scans x Pixels		Raw/Radiance value of each pixel
02	aod	32 bit float	Scans x Pixels		Raw/Radiance value of each pixel
03	tsm	32 bit float	Scans x Pixels		Raw/Radiance value of each pixel
04	dac	32 bit float	Scans x Pixels		Raw/Radiance value of each pixel

Table4: Details of Geophysical Data group

5.1.6 Navigation Data group

No	SDS Name	Data Type	Array Size	Value	Remarks
01	longitude	32 bit float	Scans x Pixels	Between -180 to +180	Longitude of each Scan line/pixel
02	latitude	32 bit float	Scans x Pixels	Between -90 to +90	Latitude of each Scan line/pixel
03	solz	32 bit float	(Scans/10) x (Pixels/10)		Solar zenith angle
04	sola	32 bit float	(Scans/10) x (Pixels/10)		Solar azimuth angle
05	senz	32 bit float	(Scans/10) x (Pixels/10)		Sensor zenith angle
06	sena	32 bit float	(Scans/10) x (Pixels/10)		Sensor azimuth angle
07	orb_vec	32 bit float	Scans x 3	Between -7200 to 7200	Orbit position vector at scan line time in Kms
08	att_ang	32 bit float	Scans x 3	Between	Computed yaw,

				-180 to +180	roll, pitch in degrees

Table-5: Details of Navigation Data group

5.1.7 Map Projection Group

No.	Field name	Data Type	Values	Remarks
1	reference_datum	Character	= NONE = WGS 84	Datum used in creating image Refer APPENDIX-B-2
2	reference_ellipsoid	Character	= NONE = WGS 84 =EVEREST	Ellipsoid used in creating image Refer APPENDIX-B-1
3	resampling_option	Character	=NONE No Resampling Done =NN Nearest Neighbor =CC Cubic Convolution	Resampling option used in creating Image
4	map_projection	Character	= NONE No Map Projection = GEOG Geographic = LCC LambertsConformal Conic = UTM Universal Transverse Mercator	Map projection used in creating image Refer APPENDIX-A
5	tie_pt_x	64 bit float		Upper left X in (tie point)meters
6	tie_pt_y	64 bit float		Upper left Y in (tie point)meters
7	projection_parameter_01	64 bit float	The data type is	Refer APPENDIX-

			double.	C Semi Major axis of the Ellipsoid
8	projection_parameter_02	64 bit float	"	Semi Minor axis of the Ellipsoid
9	projection_parameter_03	64 bit float	"	Refer Appendix for Details of Projection Parameters.
	……		"	"
21	projection_parameter_15	64 bit float	"	"

Table-6: Details of Map Projection group

5.1.8 L2 Flag Data Group

This Group is available only in **L2B** Products.

No	SDS Name	Data Type	Array Size	Value	Remarks
01	l2_flags	8-bit integer **Interpretation of Each Bit are as follows:** Bit 0: Open Water Bit 1: Turbid Water Bit 2: Shallow Water Bit 3: Land Bit 4: Cloud and Glint Over Ocean Bit 5: High Solar Zenith Bit 6 to Bit 7: Not Used (always Zero)	Scans x Pixels		8 bit Flag for each each pixel of dataset is given. If the value in the valid bits (1 to 5) are set as 1, then that flag is set else not set. If more than one bit are set, then it implies more than one flag is applicable.

Table-7: Details of L2 Flag Data Group

For L2B Products, the parameters will be calculated for all the pixels **EXCEPT** where **Land** or **Cloud over Ocean** Flag is set. The usable values (high confidence values) of the parameters will be corresponding to those pixels where Flag Value is 1 (Only Bit 0 is set to 1 and rest all other bits are set 0). Land Flag is based on Land/Ocean Mask. In Ocean:

1. Shallow water flag is defined where

   bathymetry < 30 m.

   Rest is open ocean

2. Turbid Water Flag: It is based on threshold of Water Leaving Reflectance of Band-6.

Open Ocean and Shallow water flags are exclusive.

5.1.9 Geophysical Dataset Attributes

No	Attribute Name	Meaning
1	long_name	Descriptive Name of the Dataset (CF Convention Attribute)
2	valid_range	Valid Range of the Attribute (CF Convention Attribute)
3	Units	Units of the quantity in the dataset (CF Convention Attribute)
4	grid_mapping	CF Convention Attribute used for geo-locating the dataset.
5	_FillValue	Attribute defining the fill value used in the dataset to indicate the missing value
6.	scan_sampling	Sampling frequency in scan direction w.r.t. Latitude/Longitude Datasets
7.	pixel_sampling	Sampling frequency in pixel direction w.r.t. Latitude/Longitude Datasets

APPENDIX-A : Map Projections

This appendix contains the map projections used in OCM-2 products. This list of map projections shows the name and the identifier used in Map Projection record.

Projection Name	Mnemonic
Universal Transverse Mercator	UTM
State Plane Coordinate System	SPCS
Albers Conical Equal Area	ACEA
Lambett's Conformal Conic	LCC
Mercator	MER
Polar Stereographic	PS
Polyconic	PC
Equidistant Conic (Type A & B)	EC
Transverse Mercator (Gauss-Krugger)	TM
Transverse Mercator	TM
Stereographic	SG
Lamberts Azimuthal Equal Area	LAEA
Azimuthal Equidistant	AE
Gnomonic	GNO
Orthographic	OG
General Vertical Near-Side Perspective	GVNP
Sinusoidal	SIN
Equirectangular (Plate Career)	ER
Miller Cylindrical	MC

Van Der Grintern I	VDG
Oblique Mercator (Type A & B)	OM
Space Oblique Mercator	SOM

APPENDIX- B-1 : Earth Ellipsoids

This appendix contains the earth ellipsoids used in products. This list of ellipsoids shows the name and the identifier used in Map Projection Record.

Ellipsoid Name	Semi-Major Axis (meters)	Semi-Minor Axis (meters)	Mnemonics
Clarke 1866	6378206.400000	6356583.800000	CLARKE_1866
Clarke 1880	6378249.145000	6356514.869550	CLARKE_1880
International 1967	6378157.500000	6356772.200000	INTERNATL_1967
International 1909	6378388.000000	6356911.646130	INTERNATL_1909
WGS 66	6378145.000000	6356759.769356	WGS_66
WGS 72	6378135.000000	6356750.519915	WGS_72
WGS 84	6378137.000000	6356752.314000	WGS_84
GRS 1980	6378137.000000	6356752.314140	GRS_80
Airy	6377563.396000	6356256.910000	AIRY
Modified Airy	6377340.189000	6356034.448000	MODIFIED_AIRY
Everest	6377276.345200	6356075.41330	EVEREST
Modified Everest	6377304.063000	6356103.039000	MODIFIED_EVEREST
Mercury 1960	6378166.000000	6356784.283666	MERCURY_1960
Modified Mercury 1968	6378150.000000	6356768.337303	MOD_MERC_1968
Bessel	6377397.155000	6356078.962840	BESSEL
Walbeck	6376896.000000	6355834.846700	WALBECK
Southeast Asia	6378155.000000	6356773.320500	SOUTHEAST_ASIA
Australian Natl.	6378160.000000	6356774.719000	AUSTRALIAN_NATL
Krassovsky	6378245.000000	6356863.018800	KRASSOVSKY
Hough	6378270.000000	6356794.343479	HOUGH
6370997 Sphere	6370997.000000	6370997.000000	6370997_M_SPHERE

APPENDIX- B-2: Ellipsoid and Datum Mnemonics

Ellipsoid Name	Ellipsoid Mnemonic	Possible Datum Name	Datum Mnemonics
Clarke 1866	CLARKE_1866	Datum_North_American_Datum_1927	NAS-E
Clarke 1880	CLARKE_1880	Datum_Adindan	ADI-M
International 1967	INTERNATL_1967	Datum_New_Zealand_Geodetic_Datum_1949	GEO
International 1909/1924	INTERNATL_1909	Datum_European_Datum_1950	EUR-M
WGS 66	WGS_66	WGS_66	WGS_66
WGS 72	WGS_72	WGS_72	WGS_72
WGS 84	WGS_84	WGS_84	WGS_84
GRS 1980	GRS_80	Datum_North_American_Datum_1983	NAR-B
Airy	AIRY	Datum_OSGB_1936	OGB_M
Modified Airy	MODIFIED_AIRY	Datum_TM65	IRL
Everest	EVEREST	Datum_Kalianpur	IND-I
Modified Everest	MODIFIED_EVEREST	Datum_Kalianpur	IND-I
Mercury 1960	MERCURY_1960	NOT DEFINED	
Modified Mercury 1968	MOD_MERC_1968	NOT DEFINED	
Bessel	BESSEL	Datum_Tokyo	TOY-M
Walbeck	WALBECK	Datum_European_Datum_1950	EUR-M
Southeast Asia	SOUTHEAST_ASIA	Datum_Southasia	SOA
Australian Natl.	AUSTRALIAN_NATL	Datum_Australian_Geodetic_datum_1984	AUG
Krassovsky	KRASSOVSKY	Datum_Pulkovo_1942	PUK
Hough	HOUGH	Datum_Wake-Eniwetok_1960	ENW
6370997 Sphere	6370997_M_SPHERE	NOT DEFINED	

APPENDIX – C : USGS Projection Parameters

OCM-2 Map Projection Record Supports 17 USGS projections. For all projections except State Plane, USGS parameters 1 and 2 are semi major and minor axes of the requested earth ellipsoid.

* Not every parameter will be used by the designated projection.

* If a parameter is not used the field for the parameter will be initialized to Zero.

* All latitude and longitude fields will be specified in Decimal Degree (floating point)

* All other fields will be specified as double precision floating point values.

Please note that all co-ordinates for State Plane System contained in the Map Projection Record are in map metres (not in feet).

C1(U) Universal Transverse Mercator (UTM)

Parameter 3* UTM Zone number (Optional)

C2(A) Albers Conical Equal Area (ACEA)

Parameter 3	Latitude of first Standard Parallel
Parameter 4	Latitude of second Standard Parallel
Parameter 5	Longitude of central meridian
Parameter 6	Latitude of projection's Origin
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C3(L) Lamberts Conformal Conic (LCC)

Parameter 3	Latitude of first Standard Parallel
Parameter 4	Latitude of second Standard Parallel
Parameter 5	Longitude of central meridian
Parameter 6	Latitude of projection's Origin
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C4(M) Mercator (Mer)

Parameter 5	Longitude of central meridian
Parameter 6	Latitude of projection's Origin
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C5(D) Polar Stereographic (PS)

Parameter 5	Longitude directed straight down below pole of map
Parameter 6	Latitude of true scale
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C6(P) Polyconic (POL)

Parameter 5	Longitude of central meridian
Parameter 6	Latitude of projection's Origin
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C7(T) Tranverse Mercator (TM)

Parameter 3	Scale Factor at central meridian
Parameter 5	Longitude of central meridian
Parameter 6	Latitude of projections's origin
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C8(H) Stereographic (SG)

Parameter 5	Longitude of central meridian
Parameter 6	Latitude of centre of projection
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C9(Z) Lamberts Azimuthal Equal Area (LAEA)

Parameter 5	Longitude of central meridian
Parameter 6	Latitude of centre of projection
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C10(E) Azimuthal Equidistant (AE)

Parameter 5	Longitude of central meridian
Parameter 6	Latitude of centre of projection
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C11(G) Gnomonic (GNO)

Parameter 5	Longitude of central meridian
Parameter 6	Latitude of centre of projection
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C12(R) Orthographic (OG)

Parameter 5	Longitude of central meridian
Parameter 6	Latitude of centre of projection
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C13(N) General Vertical Near-Side Perspective (GVNP)

Parameter 3	Height of perspective point above sphere
Parameter 5	Longitude of centre of projection
Parameter 6	Latitude of centre of projection
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C14(I) Sinusoidal (SIN)

Parameter 5	Longitude of central meridian
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C15(C) Miller Cylinderical (MC)

Parameter 5	Longitude of central meridian
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C16(V) Van Der Grinten (VDG)

Parameter 5	Longitude of central meridian
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

C17(S) Space Oblique Mercator (SOM)

Parameter 4	Angle of azimuth east of north for central line of projection
Parameter 9	Longitude of the ascending Node
Parameter 11	Longitude of descending Node

C18(K) Tranverse Mercator (Gauss-Krugger)(TM)

Parameter 3	Scale Factor at central meridian
Parameter 5	Longitude of central meridian
Parameter 6	Latitude of projections's origin
Parameter 7	False Easting (in metres)
Parameter 8	False Northing (in metres)

APPENDIX – D: Product Metadata Format

Fields that are not valid for a specific product type have been filled with "-NA-".

Sr. No	Field Name	Data Type/ Dimension	Values/Format Range/Unit	Description/ Remark
1	SatId	Char [2]	=O2 for OCEANSAT-2	Two character Satellite ID.
2	SatName	Char [10]	= OCEANSAT-2	Name of the Satellite
3	SensorId	Char [5]	=OCM-2	Name of the Sensor
4	DateOfPass	Char [9]	DDMMMYYYY	Date of Acquisition
5	Path	Int	=009	Path
6	Row	Int	=014	Row
7	DateOfProcessing	Char [9]	DDMMMYYYY	Date of Processing; Date of product Generation
8	TimeOfProcessing	Char[4]	HHMM in ZULU	Time of Processing; Time of Product Generation
9	GenAgency	Char[12]	Product Generating agency. NRSA for National Remote Sensing agency	
10	AcqMode	Char[3]	=GAC for Global Area Coverage =LAC for Local Area Coverage	
11	AcqType	Char[3]	=PLD Payload =SSD SSR day =SSN SSR night	Type of acquisition
12	ProcLevel	Char[3]	L1B : Radiometrically Corrected Product (RADIANCE Product) L1C : Geometrically Corrected Georeferenced (GR) Product L2B : Geophysical Parameter Product (GP) (No Geometric Correction) L2C : Geometrically corrected Geophysical Parameter Product (GP) L3A/L3B: Binned Geophysical Parameter Product	Level of corrections applied.
13	ProductType	Char[25]	=RAW (for L1A) =RADIANCE (for L1B) =GEOREF (for L1C) =RADIANCE_GEOPHY (forL2B) =GEOREF_GEOPHY (for L2C)	Product type
14	ProductCode	Char[9]	e.g. =ST00001HD (For L1B Products) =STLC00GHD (For L1C GR Products) = STLC002HD (For L02 GP	Nine Character Product Code indicating . **Product Type** ST : For L1B and L1C GR

			Products) =SPLC003HD (For L3 Binned GEOPHY Products) These Nine Characters are as follows. 1-2 : Product Type e.g. ST /SP. 2 : Projection Code(L/U) 3 : Resampling Option(C/N) 4 : Not used (Zero) 5 : Not used (Zero) 6 : Processing Level (1/2/G/3) 7 : Output Format (H) 8 : Output Media (J/V/D)	product. SP : For L02 GP and L3 Special Products **Projection Code** L : Lambert's Conformal Conic (LCC) U : Universal Transverse Mercator (UTM) **Resampling Option** C : Cubic Convolution (CC) **Processing Level** 1 : for L1B RADIANCE Product G : for L1C GEOREF Products 2 : for L2B/L2C Geophysical Parameter (GEOPHY) products 3: for binned GEOPHY products **Output Format** H : HDF **Output Media** J : CDROM V : DVD D : Disk
15	OrbitNumber	Int	For Future Use.Currently dummy(default 9999).	For Future Use.Currently dummy(default 9999).
16	NoScans	Int	=nnnn	Number of Scan Lines
17	NoPixels	Int	=nnnn	Number of Pixels
18	BytesPerPixel	Int	=2/4	Based on Product Type
19	ResolAlong	Double		Output Resolution in Meters (Along Track)
20	ResolAcross	Double		Output Resolution in Meters (Across Track)
21	NoOfBands	Int	=8 for Standard products, 1 for Geophysical Products.	Number of Bands (e.g. 8)
22	SpectralBands	Char[8]	=12345678 for Standard Product =1 for geo-physical products.	Band Numbers or Geophysical Parameter code
23	Datum	Char[20]	= WGS-84 or IND-I	Datum used in creating image
24	Ellipsoid	Char[20]	= WGS-84 = EVEREST	Ellipsoid used in creating image

25	ResampMethod	Char[4]	=NONE No Resampling Done (For RADIANCE Products) =NN Nearest Neighbor =CC Cubic Convolution	Resampling option used in creating Image
26	MapProjection	Char[4]	= NONE No Map Projection = LCC Lambert's Conformal Conic = UTM Universal Transverse Mercator	Map projection used in creating image
27	ProductFormat	Char[6]	HDF4	Data products format type
28	UniqueId	Char[20]	=SS_DDMMMYYYY_PPP_RRR Where SS = Satellite Name = O2 for OCEANSAT-2. DDMMMYYYY= Date of acquisition PPP = Path RRR=Row	ASCII string indicating the unique long request Number.
29	HDFFileName	Char [37]	=SS_DDMMMYYYY_PPP_RRR_CCX_LPP_TT_D.hdf Where **SS = Satellite Name** = O2 for OCEANSAT-2. DDMMMYYYY= Date of acquisition **PPP = Path** **RRR=Row for LAC and Strip number for GAC** **CC = Area Coverage** = LA for Local area Coverage = GA for Global Area Coverage **X** = Pass Type P for Payload (valid for LAC) D for SSR day (valid for LAC and GAC) N for SSR night (valid for LAC an GAC) **LPP = Processing Level** = L1B ,L1C,L2B,L2C, L3A,L3B **TT = Product Name Mnemonics** = ST for RADIANCE (L1B)	ODPGS-generated HDF file For example a Oceansat-2 L1B LAC product of 10 DEC 2006, of Path/Row 100/60 will have name O2_10DEC2007_100_060_LAC_L1B_ST_S.hdf For Binned products the DDMMMYYYY will correspond to the start date of binning. NOTE: For all media products HDF file nomenclature will be based on JobId.. i.e. JobId(12 Char).hdf

			Products = GR For Georeference (L1C) products. = Geo-physical parameter name Mnemonics for GEOPHY products(L02/L03) =CL for Chlorophyll =SE for Suspended Sediment =AO for Aerosol Optical Depth =DA for Defused Attenuation **D = The Flag Indicating Single** Scene or Period of Binned Data. = S For Single Scene = W For Weekly Binned = M For Monthly Binned = Y For Yearly Binned	
30	CorrULLat	Double	Corrected Upper Left (UL) Latitude -90.0000000 through +90.0000000 degrees (with 7-point precision)	
31	CorrULLon	Double	Corrected Upper Left (UL) Longitude -180.0000000 through +180.0000000 degrees (with 7-point precision)	
32	CorrULMapX	Double	CorrectedUpper Left (UL) Projection X co-ordinate In Meters.	
33	CorrULMapY	Double	CorrectedUpper Left (UL) Projection Y co-ordinate In Meters.	
34	CorrURLat	Double	Corrected Upper Right (UR) Latitude -90.0000000 through +90.0000000 degrees (with 7-point precision)	
35	CorrURLon	Double	Corrected Upper Right (UR) Longitude -180.0000000 through +180.0000000 degrees (with 7-point precision)	
36	CorrURMapX	Double	Corrected Upper Right (UR) Projection X co-ordinate In Meters.	
37	CorrURMapY	Double	Corrected Upper Right (UR) Projection Y co-ordinate In Meters.	
38	CorrLLLat	Double	Corrected Lower Left (LL) Latitude -90.0000000 through +90.0000000 degrees (with 7-point precision)	
39	CorrLLLon	Double	Corrected Lower Left (LL) Longitude -180.0000000 through +180.0000000 degrees (with 7-point precision)	
40	CorrLLMapX	Double	Corrected Lower Left (LL)	

			Projection X co-ordinate in Meters.	
41	CorrLLMapY	Double	Corrected Lower Left (LL) Projection Y co-ordinate in Meters.	
42	CorrLRLat	Double	Corrected Lower Right (LR) Latitude -90.0000000 through +90.0000000 degrees (with 7-point precision)	
43	CorrLRLon	Double	Corrected Lower Right (LR) Longitude -180.0000000 through +180.0000000 degrees (with 7-point precision)	
44	CorrLRMapX	Double	Corrected Lower Right (LR) Projection X co-ordinate in Meters.	
45	CorrLRMapY	Double	Corrected Lower Right (LR) Projection Y co-ordinate in Meters.	
46	CorrCentreLat	Double	Corrected Centre Latitude in degrees	
47	CorrCentreLon	Double	Corrected Centre Longitude in degrees	
48	CorrCentreMap X	Double	Corrected Centre Projection X co-ordinate in Meters.	
49	CorrCentreMap Y	Double	Corrected Centre Projection Y co-ordinate in Meters.	
50	CentreScan	int	Corrected Centre Scan line number	
51	CentrePix	int	Corrected Centre Pixel number	
52	ProjParam01	Double	Projection Parameters (default 0.0) Same as 15 USGS parameters	
53	ProjParam02	Double		
54	ProjParam03	Double		
55	ProjParam04	Double		
56	ProjParam05	Double		
57	ProjParam06	Double		
58	ProjParam07	Double		
59	ProjParam08	Double		
60	ProjParam09	Double		
61	ProjParam10	Double		
62	ProjParam11	Double		
63	ProjParam12	Double		
64	ProjParam13	Double		
65	ProjParam14	Double		
66	ProjParam15	Double		
67	SatHeadAngle	Double	Degrees	Satellite Heading Angle at Scene Center
68	SatAltitude	Double	Kilometers	Actual Satellite Altitude
69	SunElevAngle	Double	Degrees	Scene Centre Sun Elevation Angle
70	SunAzimAngle	Double	Degrees	Scene Centre Sun Azimuth Angle
71	SatElevAngle	Double	Degrees	Satellite Elevation Angle
72	SatAzimAngle	Double	Degrees	Satellite Azimuth Angle

APPENDIX – E: Sun Zenith Angle Variation along latitude across the year

Time / Lat	01-JAN	15-JAN	01-FEB	15-FEB	01-MAR	15-MAR	01-APR	15-APR	01-MAY	15-MAY
85	108.09	106.22	102.22	97.81	92.36	86.91	80.25	75.06	69.80	66.06
80	103.07	101.25	97.28	92.89	87.42	81.94	75.24	70.02	64.74	60.99
75	98.09	96.28	92.33	87.94	82.46	76.98	70.27	65.04	59.75	56.00
70	93.10	91.31	87.37	82.98	77.51	72.02	65.30	60.06	54.76	51.02
65	88.12	86.34	82.42	78.03	72.55	67.05	60.32	55.08	49.78	46.03
60	83.14	81.37	77.46	73.08	67.60	62.10	55.36	50.10	44.80	41.05
55	78.16	76.41	72.51	68.13	62.66	57.14	50.39	45.13	39.82	36.08
50	73.18	71.44	67.56	63.19	57.71	52.20	45.43	40.16	34.85	31.11
45	68.20	66.47	62.61	58.25	52.78	47.26	40.48	35.21	29.89	26.15
40	63.22	61.51	57.67	53.32	47.85	42.33	35.54	30.26	24.94	21.20
35	58.25	56.56	52.73	48.40	42.94	37.41	30.62	25.33	20.01	16.30
30	53.28	51.60	47.80	43.49	38.04	32.52	25.72	20.43	15.13	11.46
25	48.31	46.66	42.89	38.60	33.17	27.66	20.87	15.60	10.36	6.87
20	43.34	41.72	38.00	33.74	28.34	22.85	16.11	10.91	5.96	3.59
15	38.39	36.80	33.13	28.92	23.57	18.14	11.54	6.68	3.71	5.34
10	33.44	31.90	28.29	24.16	18.91	13.64	7.52	4.48	6.48	9.70
5	28.51	27.03	23.53	19.51	14.48	9.62	5.47	6.74	10.96	14.48
0	23.61	22.21	18.88	15.09	10.54	7.00	7.29	10.99	15.75	19.37
-5	18.76	17.49	14.45	11.14	7.91	7.42	11.23	15.68	20.64	24.30
-10	14.00	12.98	10.52	8.39	7.97	10.53	15.78	20.52	25.57	29.25
-15	9.50	8.97	7.91	8.14	10.69	14.72	20.54	25.41	30.52	34.22
-20	5.85	6.52	8.00	10.57	14.65	19.29	25.38	30.34	35.49	39.20
-25	5.30	7.37	10.74	14.39	19.10	24.02	30.28	35.29	40.46	44.18
-30	8.47	10.76	14.70	18.76	23.76	28.85	35.20	40.25	45.44	49.16
-35	12.86	15.07	19.15	23.38	28.53	33.72	40.14	45.22	50.42	54.14
-40	17.57	19.70	23.82	28.12	33.37	38.62	45.09	50.19	55.40	59.13
-45	22.41	24.48	28.59	32.93	38.24	43.54	50.05	55.17	60.39	64.12
-50	27.30	29.32	33.42	37.79	43.14	48.47	55.01	60.14	65.38	69.11
-55	32.23	34.21	38.29	42.68	48.05	53.41	59.98	65.12	70.36	74.10
-60	37.17	39.12	43.19	47.58	52.98	58.36	64.95	70.11	75.35	79.09
-65	42.12	44.05	48.10	52.50	57.92	63.31	69.92	75.09	80.34	84.08
-70	47.08	48.99	53.03	57.43	62.86	68.27	74.90	80.07	85.33	89.07
-75	52.05	53.94	57.97	62.37	67.81	73.23	79.87	85.06	90.32	94.06
-80	57.02	58.90	62.91	67.31	72.76	78.20	84.85	90.04	95.31	99.05
-85	62.00	63.86	67.86	72.26	77.71	83.16	89.83	95.03	100.30	104.04

Time / Lat	01-JUN	15-JUN	01-JUL	15-JUL	01-AUG	15-AUG	01-SEP	15-SEP	01-OCT
85	62.94	61.75	62.02	63.66	67.23	71.24	77.07	82.35	88.60
80	57.88	56.70	56.99	58.65	62.22	66.21	72.00	77.25	83.46
75	52.90	51.72	52.02	53.68	57.25	61.24	67.01	72.26	78.46
70	47.91	46.75	47.06	48.72	52.29	56.27	62.03	67.27	73.46
65	42.94	41.78	42.10	43.77	47.34	51.31	57.05	62.28	68.47
60	37.96	36.81	37.15	38.83	42.39	46.35	52.08	57.29	63.47
55	32.99	31.86	32.21	33.90	37.45	41.40	47.10	52.30	58.47
50	28.04	26.92	27.29	28.99	32.53	36.45	42.13	47.32	53.48
45	23.09	22.00	22.41	24.11	27.63	31.53	37.17	42.33	48.48
40	18.18	17.13	17.58	19.29	22.78	26.62	32.22	37.35	43.49
35	13.33	12.37	12.88	14.59	18.00	21.76	27.28	32.38	38.49

30	8.65	7.88	8.53	10.17	13.37	16.98	22.37	27.41	33.50
25	4.68	4.61	5.42	6.62	9.14	12.36	17.50	22.46	28.51
20	4.35	5.50	6.00	5.84	6.17	8.19	12.74	17.53	23.53
15	8.11	9.45	9.61	8.61	6.52	5.58	8.24	12.66	18.55
10	12.75	14.07	14.09	12.81	9.83	6.72	4.86	7.94	13.59
5	17.59	18.89	18.83	17.43	14.17	10.44	5.41	3.98	8.67
0	22.50	23.78	23.68	22.21	18.83	14.92	9.20	4.31	3.95
-5	27.43	28.71	28.58	27.07	23.63	19.65	13.79	8.44	2.47
-10	32.39	33.65	33.50	31.97	28.49	24.49	18.58	13.19	6.83
-15	37.36	38.61	38.44	36.89	33.39	29.37	23.46	18.07	11.71
-20	42.33	43.58	43.40	41.83	38.32	34.29	28.38	23.00	16.66
-25	47.31	48.55	48.36	46.78	43.26	39.23	33.33	27.95	21.63
-30	52.29	53.53	53.32	51.74	48.20	44.17	38.28	32.92	26.61
-35	57.28	58.51	58.29	56.70	53.16	49.13	43.24	37.89	31.60
-40	62.26	63.49	63.27	61.67	58.12	54.09	48.22	42.87	36.59
-45	67.25	68.47	68.24	66.64	63.09	59.06	53.19	47.86	41.58
-50	72.24	73.45	73.22	71.61	68.06	64.03	58.17	52.84	46.58
-55	77.22	78.44	78.20	76.59	73.03	69.00	63.15	57.83	51.57
-60	82.21	83.42	83.18	81.56	78.00	73.98	68.13	62.82	56.57
-65	87.20	88.41	88.16	86.54	82.97	78.95	73.11	67.81	61.57
-70	92.19	93.40	93.14	91.51	87.95	83.93	78.10	72.80	66.56
-75	97.18	98.38	98.12	96.49	92.92	88.91	83.08	77.79	71.56
-80	102.17	103.37	103.10	101.46	97.90	93.89	88.07	82.78	76.56
-85	107.16	108.35	108.08	106.44	102.87	98.86	93.05	87.78	81.55

Time / Lat	15-OCT	01-NOV	15-NOV	01-DEC	15-DEC
85	93.93	99.82	103.82	107.04	108.40
80	88.77	94.65	98.66	101.91	103.31
75	83.77	89.65	93.66	96.91	98.32
70	78.77	84.65	88.66	91.91	93.33
65	73.77	79.65	83.66	86.92	88.34
60	68.77	74.65	78.66	81.92	83.34
55	63.77	69.65	73.66	76.92	78.35
50	58.77	64.65	68.66	71.92	73.36
45	53.78	59.65	63.66	66.93	68.37
40	48.78	54.65	58.66	61.93	63.38
35	43.78	49.65	53.66	56.93	58.39
30	38.78	44.65	48.66	51.94	53.40
25	33.78	39.65	43.66	46.94	48.41
20	28.78	34.65	38.66	41.94	43.42
15	23.79	29.65	33.66	36.95	38.44
10	18.79	24.65	28.67	31.96	33.46
5	13.80	19.65	23.67	26.97	28.49
0	8.82	14.66	18.67	21.98	23.53
-5	3.89	9.66	13.68	17.00	18.59
-10	1.57	4.67	8.69	12.04	13.69
-15	6.31	0.57	3.72	7.13	8.90
-20	11.27	5.37	1.51	2.58	4.57
-25	16.26	10.36	6.38	3.54	3.54
-30	21.25	15.36	11.36	8.27	7.36
-35	26.25	20.36	16.36	13.20	12.07
-40	31.24	25.36	21.35	18.16	16.95
-45	36.24	30.35	26.35	23.15	21.88
-50	41.24	35.35	31.35	28.13	26.83

-55	46.24	40.35	36.35	33.12	31.80
-60	51.24	45.35	41.35	38.12	36.78
-65	56.24	50.35	46.35	43.11	41.76
-70	61.23	55.35	51.35	48.11	46.75
-75	66.23	60.35	56.34	53.10	51.73
-80	71.23	65.35	61.34	58.10	56.72
-85	76.23	70.35	66.34	63.10	61.71

APPENDIX – F: Effect of Sun Zenith on Water Leaving Radiance Retrieval

As far as processing of OCM2 for estimating Ocean color products is concerned, standard atmospheric correction procedure using the the two NIR bands, 745 and 865 nm with an assumption of zero water leaving radiance at NIR wavelengths has been adopted. For aerosol contribution, model for a single scattering approximation has been assumed. The diffuse transmittance t is associated with water leaving radiance component of TOA radiance which is recorded by the sensor. The diffuse transmittance t is effected by both atmosphere as well as the angular distribution of the exiting radiance. However, in the atmospheric correction procedure, we have assumed a uniform upward radiance below the sea surface for computation of t. However, this assumption has resulted in an error of more than 1% in normalized water leaving radiance in oligotrophic to mesotrophic waters (chlorophyll between 0.1 –0,5 mg/m^3) depending on the sun viewing geometry and the angular distribution of subsurface upwelling radiance. The errors were observed to be highest about 6-8 % in maximum viewing zenith at the edges of the scan ($\theta > 55°$). If the pixels are restricted to $\theta < 55°$,an error of 1-2% is observed in the normalized water leaving radiances.