

Ocean Colour Monitor (OCM) onboard OCEANSAT-2 mission

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1.0 Introduction

Space borne ocean-colour remote sensing has already been established as a tool to provide quantitative information on the sea water constituents. Ocean-colour data from the first Indian ocean observation satellite OCEANSAT-1 was extensively used for various societal and scientific applications like Potential Fishing Zone (PFZ) identification, estimation of primary productivity, algal bloom detection and studying the coastal processes. OCEANSAT-2 spacecraft of Indian Space Research Organization (ISRO) is the second satellite in ocean series, which was successfully launched on September 23, 2009 from Shriharikota by Polar Satellite Launch Vehicle (PSLV)-C14 rocket. The OCEANSAT-2 satellite carried three main instruments namely i) Ku band pencil beam scatterometer, ii) modified Ocean Colour Monitor (OCM) and iii) Radio Occultation Sounder of Atmosphere (ROSA) instrument of Italian Space Agency (ASI). The OCEANSAT-2 OCM is mainly designed to provide continuity to the OCEANSAT-1 OCM instrument and to obtain quantitative information of ocean-colour variables e.g. chlorophyll-*a* concentration, vertical diffuse attenuation of the light, (K_d) and total suspended matter (TSM) concentration in coastal waters, apart from ocean-colour information OCM data will also be useful for studying the aerosol transport and terrestrial bio-sphere. OCEANSAT-2 OCM is almost identical to OCEANSAT-1 OCM, however central wavelength of two spectral bands i.e. band 6 and 7 have been shifted. The spectral band 6, which was located at 670 nm in OCEANSAT-1 OCM has now been shifted to 620 nm for improved quantification of suspended sediments. The spectral band at 620 nm is also useful for substrate mapping of optically shallow coral reefs and other benthic ecosystems. The spectral band 7, which was located at 765 nm in OCEANSAT-1 OCM has been shifted to 740 nm to avoid oxygen (O_2A) absorption in OCEANSAT-2 OCM, this change is expected to improve the accuracy of the normalized water-leaving radiance in shorter wavelengths obtained after doing the atmospheric correction. Table 1 provides the technical details of the OCEANSAT-2 OCM instrument.

Table 1: Major specifications and features of the OCEANSAT-2 OCM

Parameters	Specifications
1. IGFOV at nominal altitude (m)	360 x 250
2. Swath (km)	1420
3. No. of spectral bands	8
4. Spectral range (nm)	402- 885
5. Spectral bands	B1 : 404-424 nm B2: 431-451 nm B3: 476-496 nm B4: 500-520 nm B5: 546-566 nm B6: 610-630 nm B7: 725-755 nm B8: 845-885 nm
6. Quantization Bits	12
7. Along track steering	$\pm 20^0$
8. Data acquisition modes	Local Area Coverage (LAC) & Global Area Coverage (GAC)

2.0 Data Products

Oceansat-2 OCM data products will be available in the HDF 4.0 format providing all the required ancillary information to process the data for ocean-colour parameter estimation. The data products from OCM-2 are available at 360 meter spatial resolution for regional studies, which are also called local area coverage (LAC) products. The global area coverage (GAC) products are available at 4 km spatial resolution for global studies. The Level 1B top of the atmosphere (TOA) radiance data from all the eight bands of OCM sensor is used along with ancillary information to generate various bio-geophysical data products. The main geophysical products from OCM-2 are chlorophyll-*a* concentration, total suspended sediment concentration, vertical diffuse attenuation coefficient (K_d -490) at 490nm and aerosol optical depth (AOD) at 865nm. These data products from OCM-2 will be used for studying oceanic primary production, fisheries resources, global carbon cycle, spatial and temporal patterns of algal blooms, dynamics of coastal currents, physics of mixing and relationship between ocean physics and large scale patterns of productivity, land-ocean interaction in the coastal zone and sediment dynamics on regional as well as global scales. The availability of ocean-colour data from OCM-2 will open new frontiers in remote sensing for open as well as coastal regions on regional and global scales due to its relatively higher spatial resolution of around 360 meters. The geophysical data products from OCEANSAT-2 OCM and estimation accuracy goals are shown in Table 2.

Table 2: Geophysical products from OCEANSAT-2 OCM data

S.No.	Parameter	Variable Range	Targeted error budget
1.	Chlorophyll- <i>a</i> concentration	0.05- 30.0 mg m ⁻³ (for case-1 waters)	<30%
2.	Vertical Diffuse attenuation coefficient (K_d) at 490-nm	0.01-0.50 m ⁻¹	< 20%
3.	Total Suspended matter (TSM) concentration	0.0-200 mg L ⁻¹	<20 %
4.	Aerosol Optical Depth (AOD) over oceans at 865-nm	0.0-1.0	<20%

3.0 Initial observations from OCEANSAT-2 OCM

The sun light backscattered from the atmosphere is typically at least an order of magnitude larger than the desired radiance scattered out of the sea water. The contributions of the water-leaving reflectance to the top of the atmosphere (TOA) reflectance decreases with the increasing wavelength and a large contribution is made by molecular and Mie scattering in atmosphere and by air molecules and aerosols. Therefore it is mandatory to correct the ocean-colour signal for atmospheric effects to estimate the reflectance of sea water just above its surface for further quantitative estimation of in-water bio-geophysical parameters from space. The last two spectral bands of OCM-2 i.e., 740 and 865 nm are used for atmospheric correction purpose. The output of atmospheric correction algorithm is then used for estimating the geophysical parameters using bio-optical algorithms. For the OCM-2 processing special features have been incorporated for doing the atmospheric correction for both LAC and GAC data. Many data quality flags such as for land, cloud, sun-glint masking, coastal waters and shallow turbid coastal water flags have been implemented. Global bathymetry data has been used for masking the land boundaries and

this data is also used for shallow water bathymetry flagging. A new algorithm for total suspended matter (TSM) concentration estimation has been used for OCM-2, which makes use 620 nm band. Figure 1 shows the example of LAC chlorophyll-*a* concentration image as captured by OCEANSAT-1 OCM on September 27, 2009 over the parts of the western Arabian Sea. This figure shows the high chlorophyll concentration off Oman coast. This high chlorophyll concentration generally occurs in this region during the late monsoon season and known to be linked to coastal upwelling along the Oman coast. Figure 2 (a & b) shows False Colour Composite (FCC) of GAC data set acquired by OCM over the parts of Barzil, South America and corresponding chlorophyll-*a* image for the parts of the Atlantic ocean.

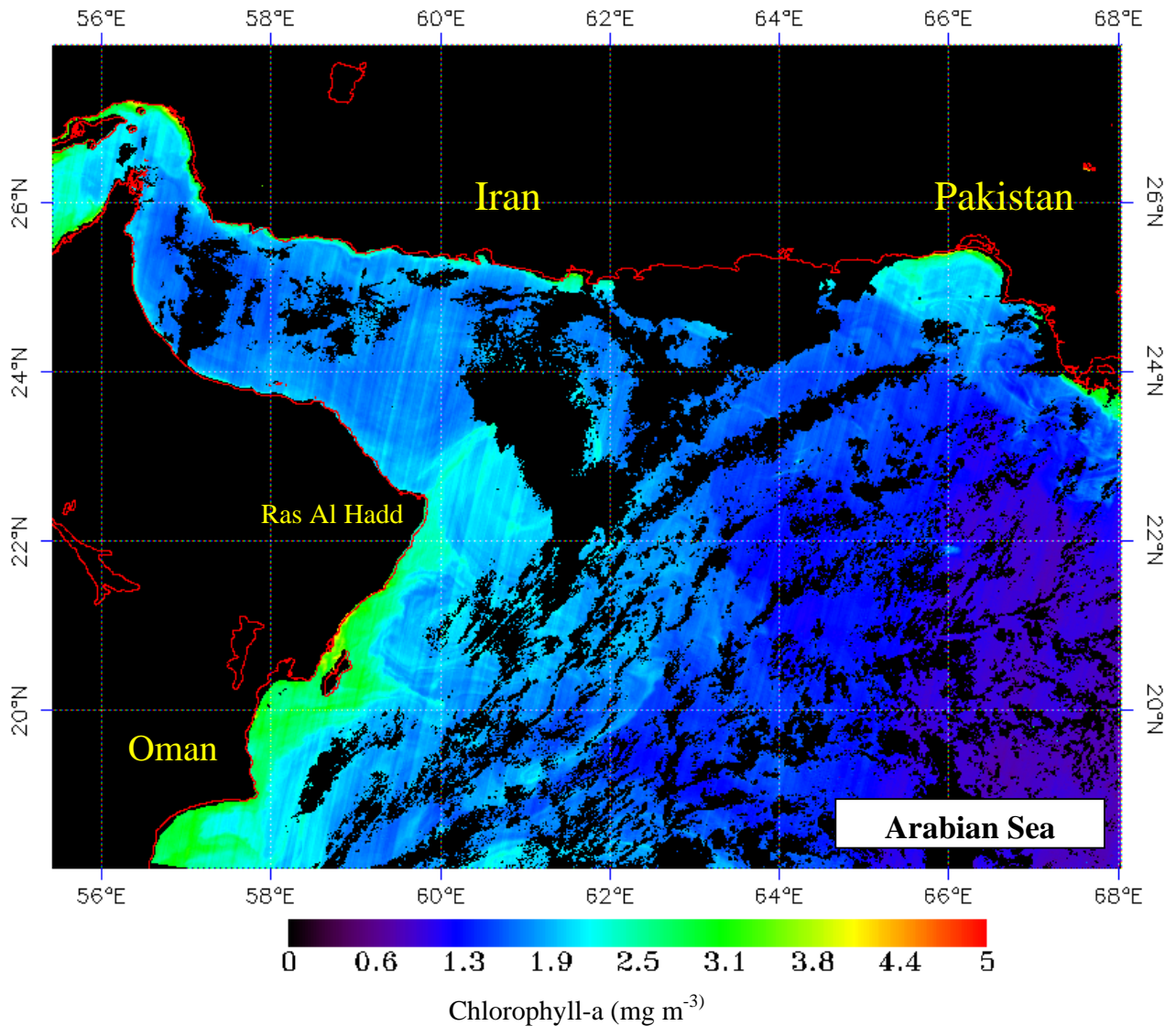


Figure 1: Chlorophyll-*a* distribution as captured by OCEANSAT-2 OCM over the parts of the western Arabian Sea.

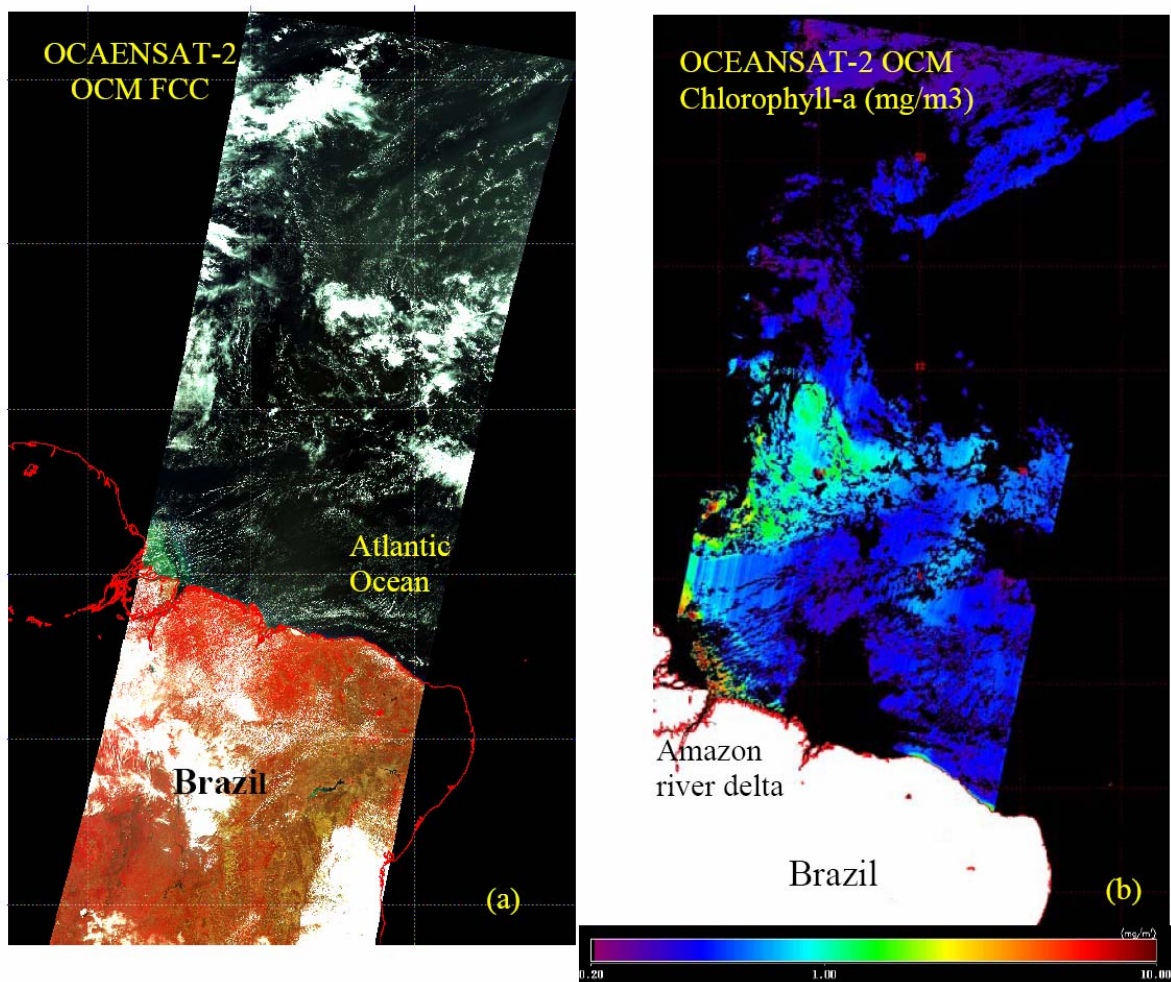


Figure 2: An example of OCAENSAT-2 GAC data (a) false colour composite (FCC) over Amazon forest, Brazil and (b) Chlorophyll-*a* image for parts of Atlantic Ocean. A high chlorophyll concentration plume is clearly seen off the Amazon river delta.

4.0 OCM data access

A comprehensive programme for OCAENSAT-2 OCM data utilisation has been drawn up in India along with a host of users. Extensive Cal/Val analysis will be undertaken for OCAENSAT-2 OCM radiance and geophysical data products and these products will be validated for their accuracy and robustness with the *in-situ* data collected during the ship campaigns in the open as well as coastal ocean waters. ISRO has established a Cal/Val optical buoy around Kavaratti Island in the Lakshadweep Sea to perform a systematic post launch vicarious calibration of the ocean-colour sensors. The data from this Cal/Val site is currently being used to assess the radiometric behavior of OCAENSAT-2 OCM data. An announcement of opportunity (AO) call inviting proposals from international PIs was opened in 2008 and seventeen proposals from ten different countries have been received. ISRO will be providing OCM data to all AO PIs after the initial Cal/Val activities are over and data is formally released for public use. ISRO will also be providing the GAC data products through a web based data dissemination system. It is expected that OCAENSAT -2 OCM data along with other ocean-colour sensors such as MERIS and MODIS will assist the international ocean-colour community in filling data gaps, and will also be used for the inter-sensor calibration of different ocean-colour sensors.