OCEAN COLOUR ACTIVITIES IN INDIA

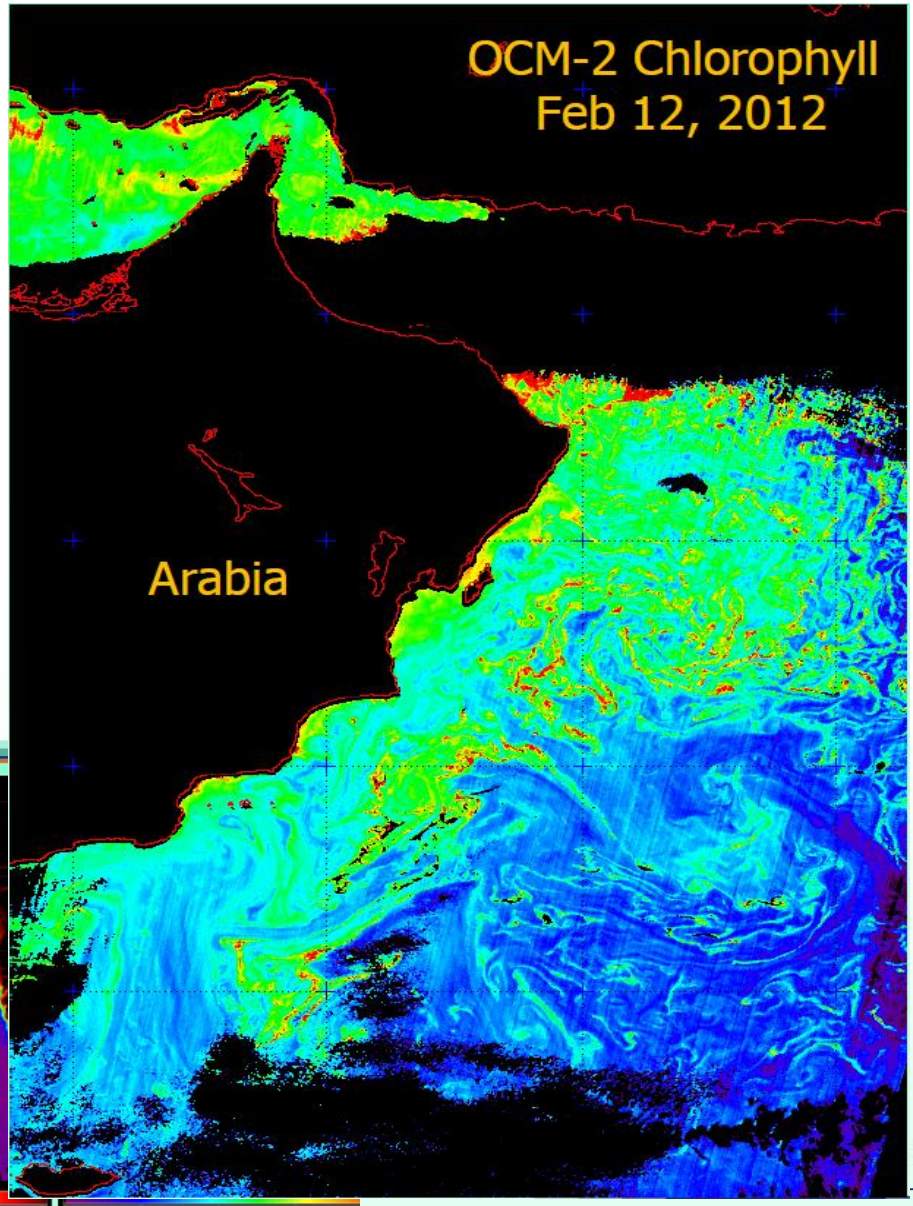
Prakash Chauhan
Indian Institute of Remote Sensing, Indian Space Research Organisation
Dehradun-248001, INDIA

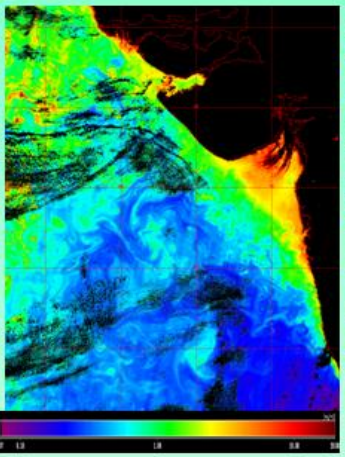
Update on Ocean Colour Activities in India

- Continuity of operations of OCEANSAT-2 OCM sensor
- Phytoplankton Bloom studies in the Arabian Sea
- Phytoplankton size estimation in the Arabian Sea using OCM data
- AVIRIS-NG Airborne Hyperspectral data for Coastal / Inland waters
- High Resolution Remote Sensing for Water Quality studies
- Update on Oceansat-3 satellite
- Mobile App for water turbidity estimation – Citizen science approach
- Ocean's Colour from Space : Images from OCEANSAT OCM
- Capacity Building for Ocean Colour in India

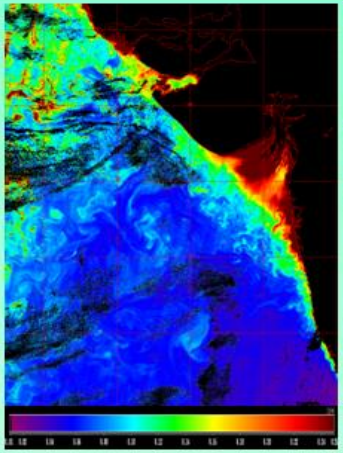
Biological Oceanography

- ***ISRO has launched OCESNSAT-2 Ocean Colour Monitor (OCM) sensor in 2009***
- ***OCM-2 is continue to provide quality data even in 2019 after ten years of operations***
- **OCM data is operationally used to asses marine living resources, p*rimary productivity, algal bloom detection and bio-physical coupling studies***

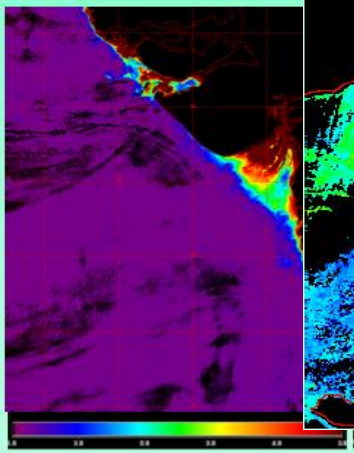




Chlorophyll-*a*



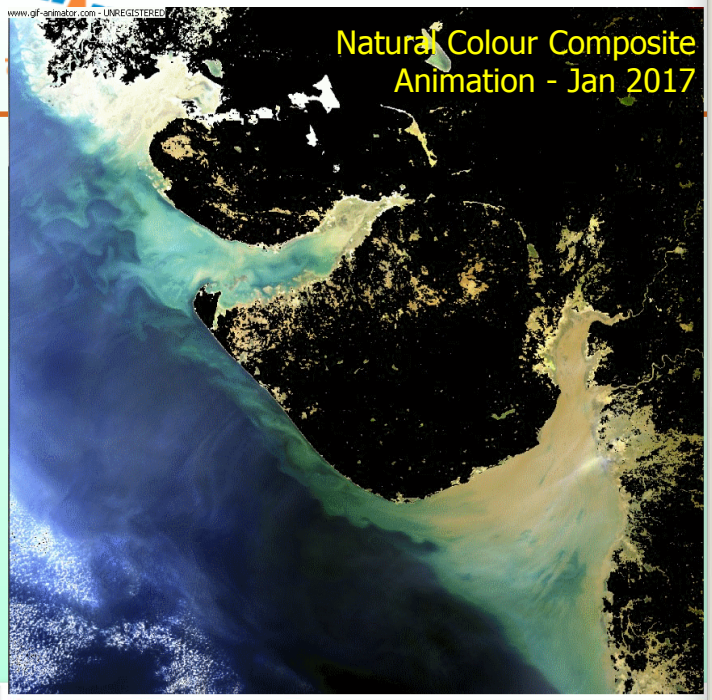
K_d *(490 nm)*

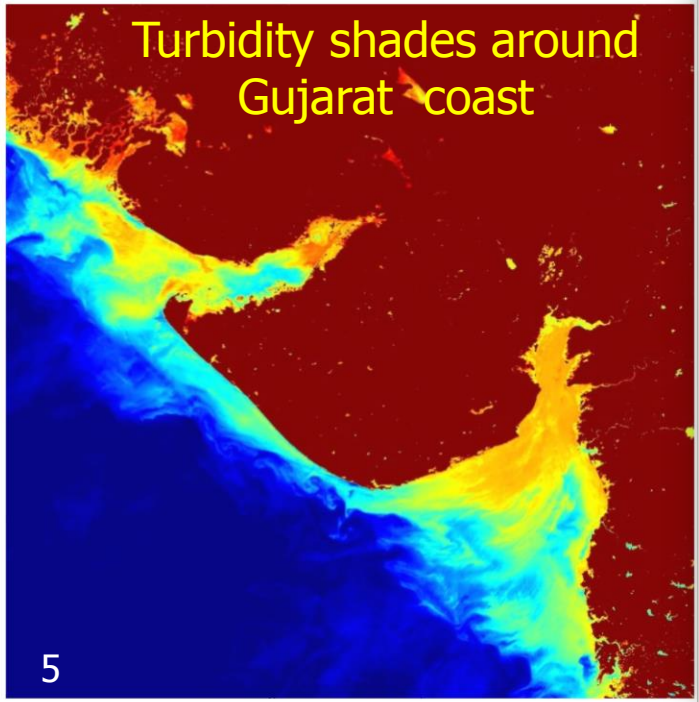


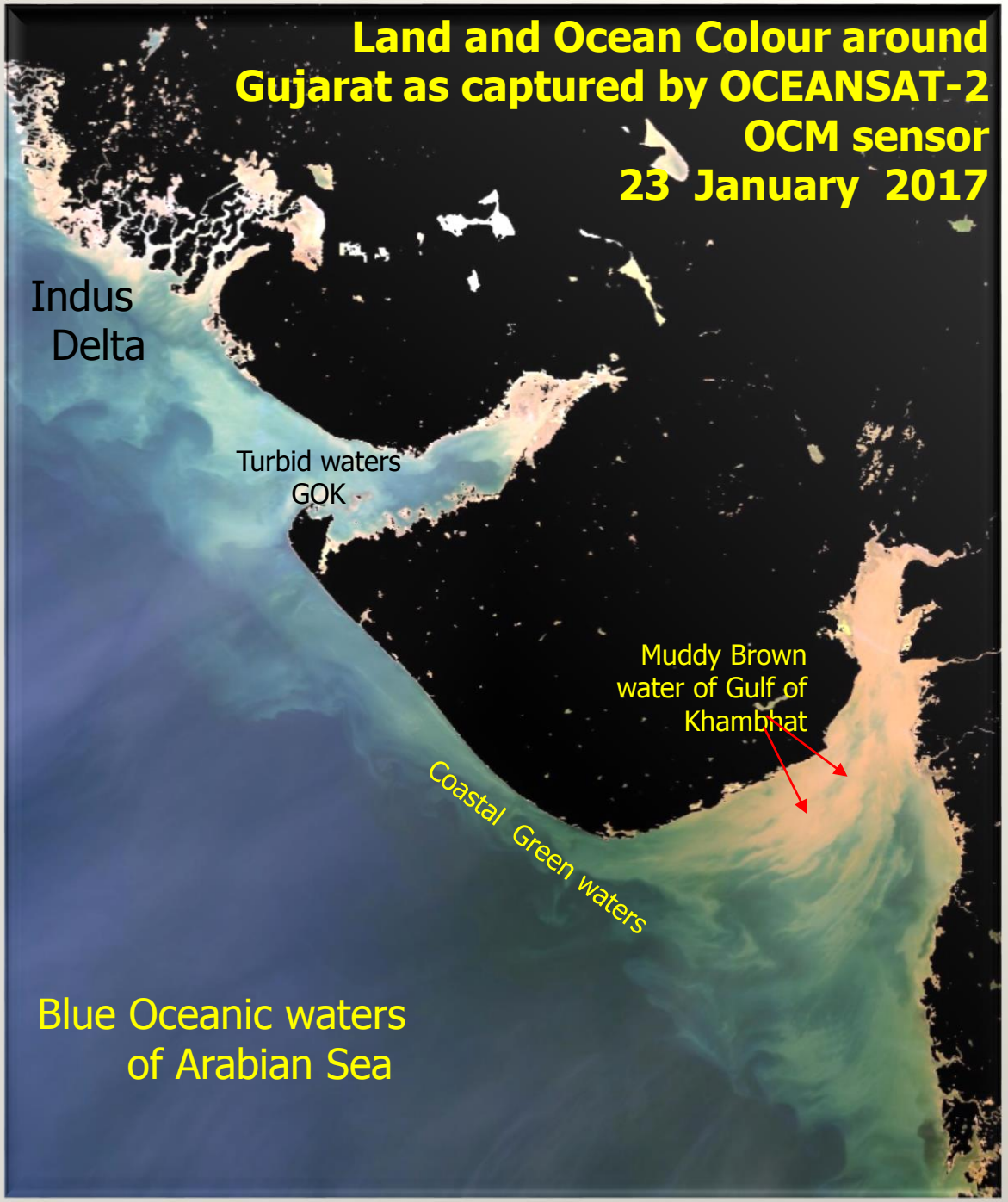
TSM

AOD (865nm)

an, Korea, April 09-12, 2019


Natural Colour Composite
Animation - Jan 2017


Turbidity shades around
Gujarat coast


Land and Ocean Colour around
Gujarat as captured by OCEANSAT-2
OCM sensor
23 January 2017
Indus
Delta
Turbid waters
GOK
Muddy Brown
water of Gulf of
Khambhat
Coastal Green waters
Blue Oceanic waters
of Arabian Sea

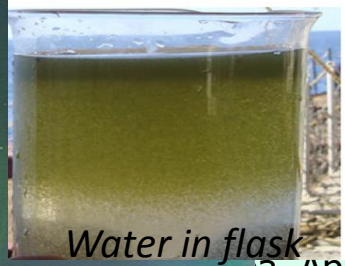
Forest of the Sea : Massive Outbreak of Noctiluca algal blooms in the Arabian Sea as captured by Indian OCEANSAT-2 OCM on Feb 8, 2018

Every year during winters north-western Arabian Sea experiences outbreak of Noctiluca algal blooms. This bloom at times causes fish mortality on Oman coast due to hypoxia.

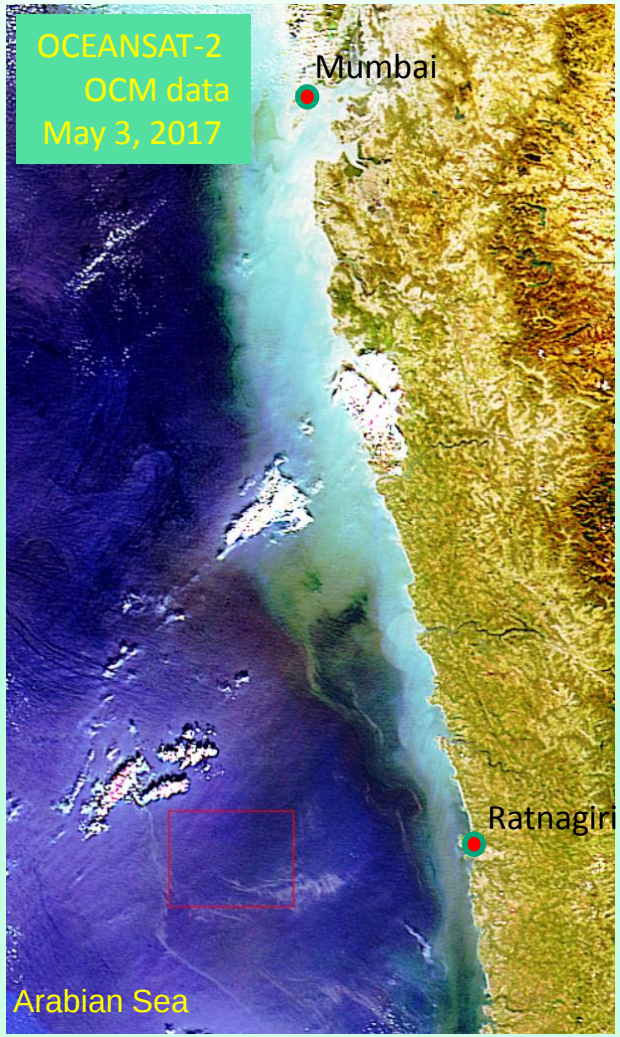
This image is captured by Indian OCM sensor on OCEANSAT-2 satellite on Feb 8, 2018.

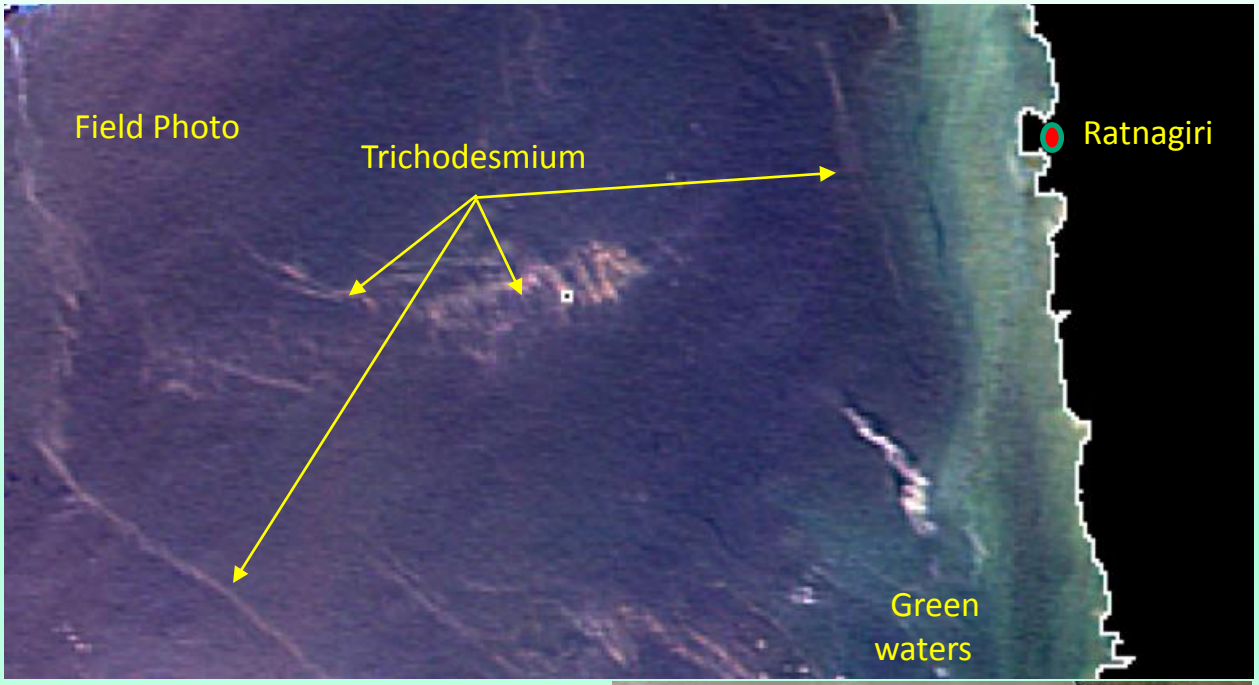
Algal bloom

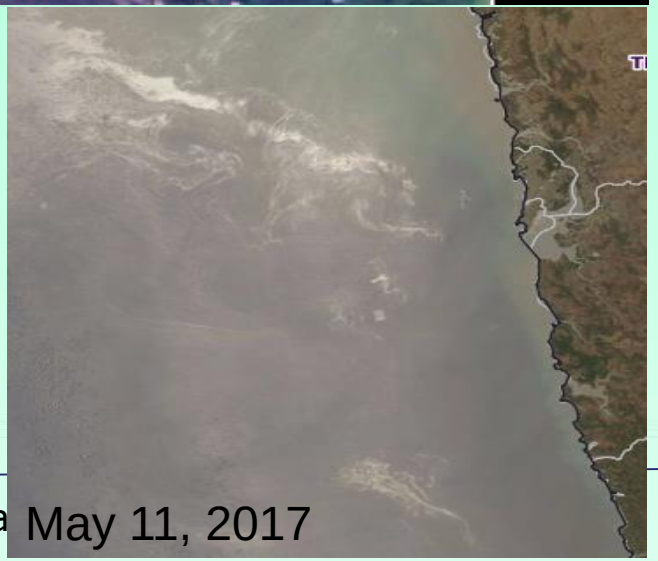
Arabian Sea



Trichodesmium Bloom detection using OCEANSAT-2 OCM data on May 3, 2017 Off Ratnagiri coast, Maharashtra, India

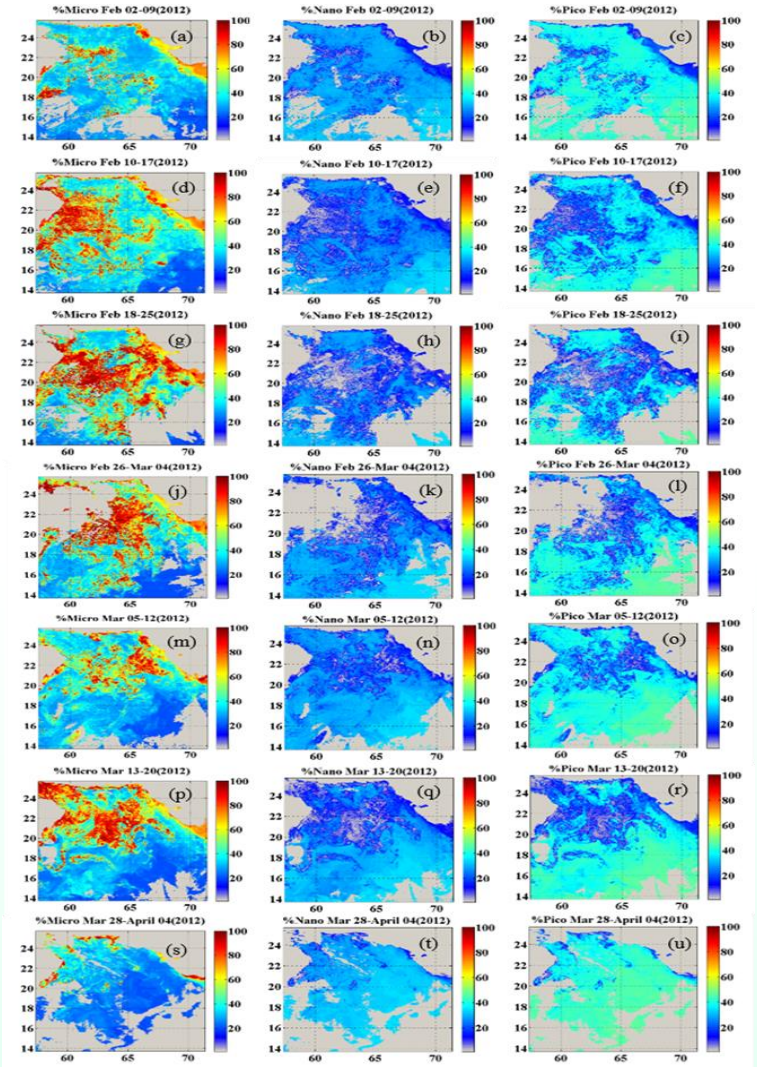






Trichodesmium spp. is nitrogen fixing marine blue-green algae commonly found in tropical oceans. They form massive blooms during summer period, when surface waters are warm and devoid of nitrate. These blooms are important for nitrogen bio-geo-chemistry of oceans.

Phytoplankton Size Class retrieved from Ocean Colour Data



Microplankton in red colour dominates high algal bloom regions whereas blue colour are pico planktons representing non bloom area.

Remote Sensing of Environment 198 (2017) 286–296

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Ocean color satellite determinations of phytoplankton size class in the Arabian Sea during the winter monsoon

Arvind Sahay [a,*], Syed Moosa Ali [a], Anurag Gupta [a], Joaquim I. Goes [b]

[a] Space Applications Centre (ISRO), Ahmedabad 380015, India

[b] Lamont Doherty Earth Observatory at Columbia University, Palisades, New York 10964, USA

ARTICLE INFO

Article history:
Received 4 September 2016
Received in revised form 6 June 2017
Accepted 8 June 2017
Available online xxxx

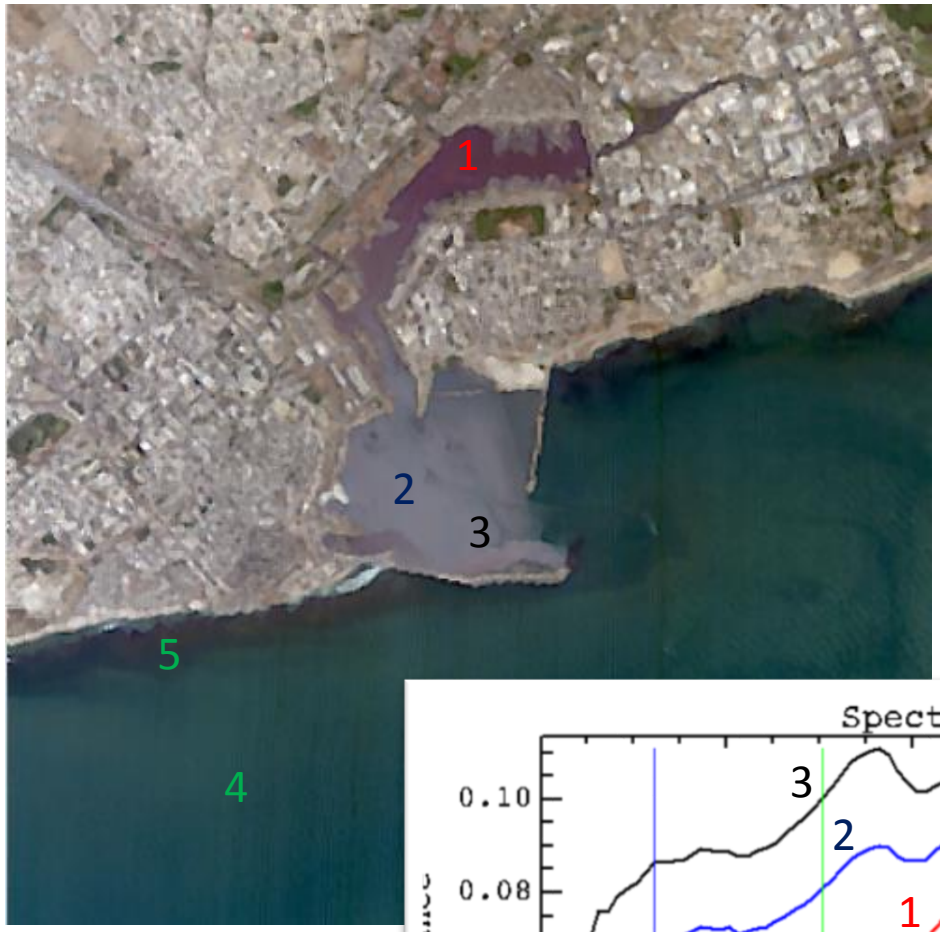
Keywords:
Phytoplankton size class
Chlorophyll-a
Arabian Sea
OCM-2
MODIS
Noctiluca

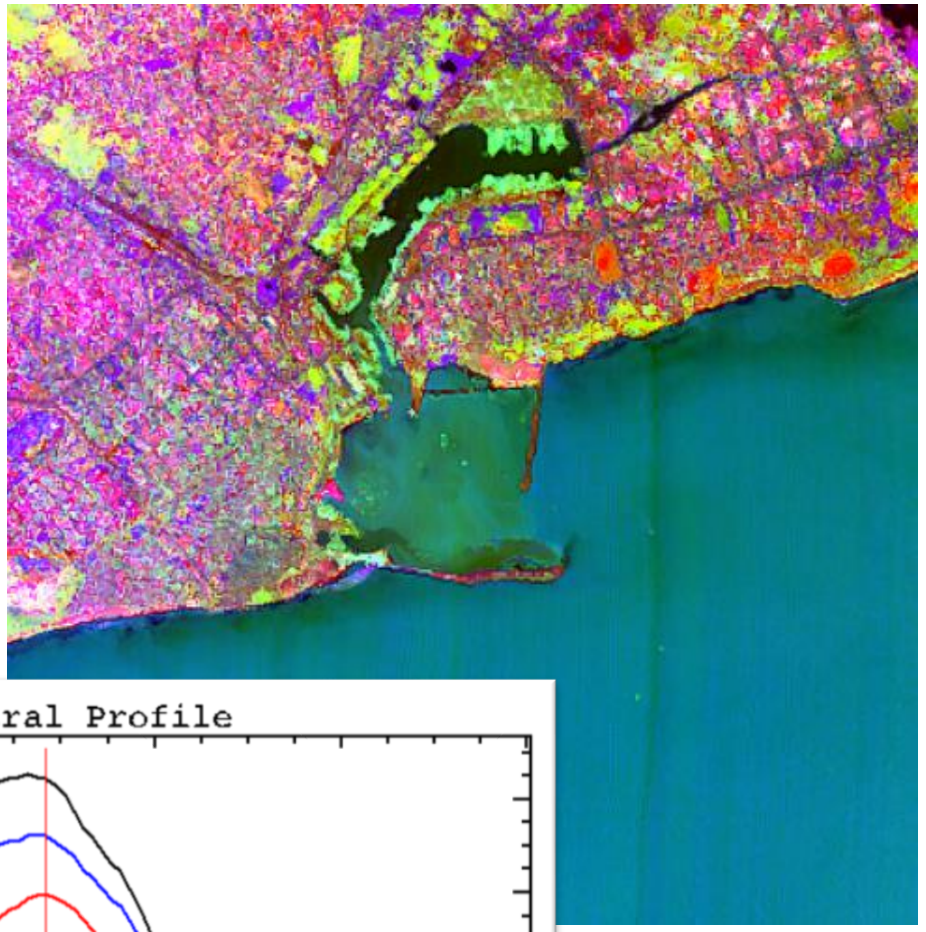
ABSTRACT

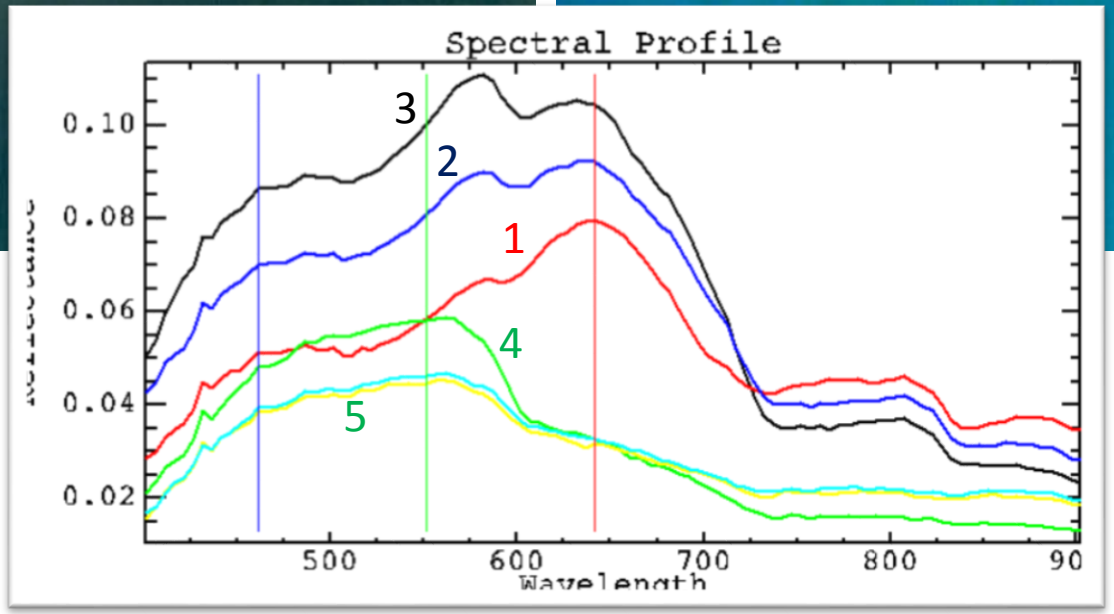
A regionally tuned three component "abundance" model of Brewin et al. (2012) has been used to discriminate satellite ocean color derived fields of phytoplankton biomass observable as Chlorophyll-a (Chl-a), into three size classes, i.e. microplankton (>20 μm), nanoplankton (>2 to <20 μm) and picoplankton (<2 μm). The model has been applied to MODIS-Aqua and Oceansat-2, Ocean Color Monitor (OCM) derived fields of Chl-a data between Nov. and Mar. In the Arabian Sea, during the evolution of blooms of the large (>800 μm sized) green mixotrophic dinoflagellate *Noctiluca scintillans*. A comparison of shipboard measured and model derived values of phytoplankton size classes (PSCs) show the superiority of the regionally tuned model over parameterizations used in the original model of Brewin et al. (2012). A total number of 39 in situ data points have been used for the tuning of the regional model and 5 different in-situ data points have been used for the comparison with in situ data in this remote region of data paucity. The absolute mean and the maximum absolute errors for all size fractions are 4.7% and 17.2% respectively, as compared to the values of 9.6% and 26% respectively obtained using Brewin et al. (2012).When applied to a weekly time series of Chl-a images, the regionally tuned model is able to capture the seasonal cycle of PSC in the Arabian Sea associated with the tail end of the fall inter-monsoon

Figure-Time series of weekly composite images of phytoplankton size class in the Arabian Sea obtained by applying regionally tuned model to MODIS Aqua Chl-a from 2nd Feb 2012 to 4th Apr 2012. The maps capture the variability pretty well in different seasons

AVIRIS-NG data over Veraval Fishing Harbour in Gujarat





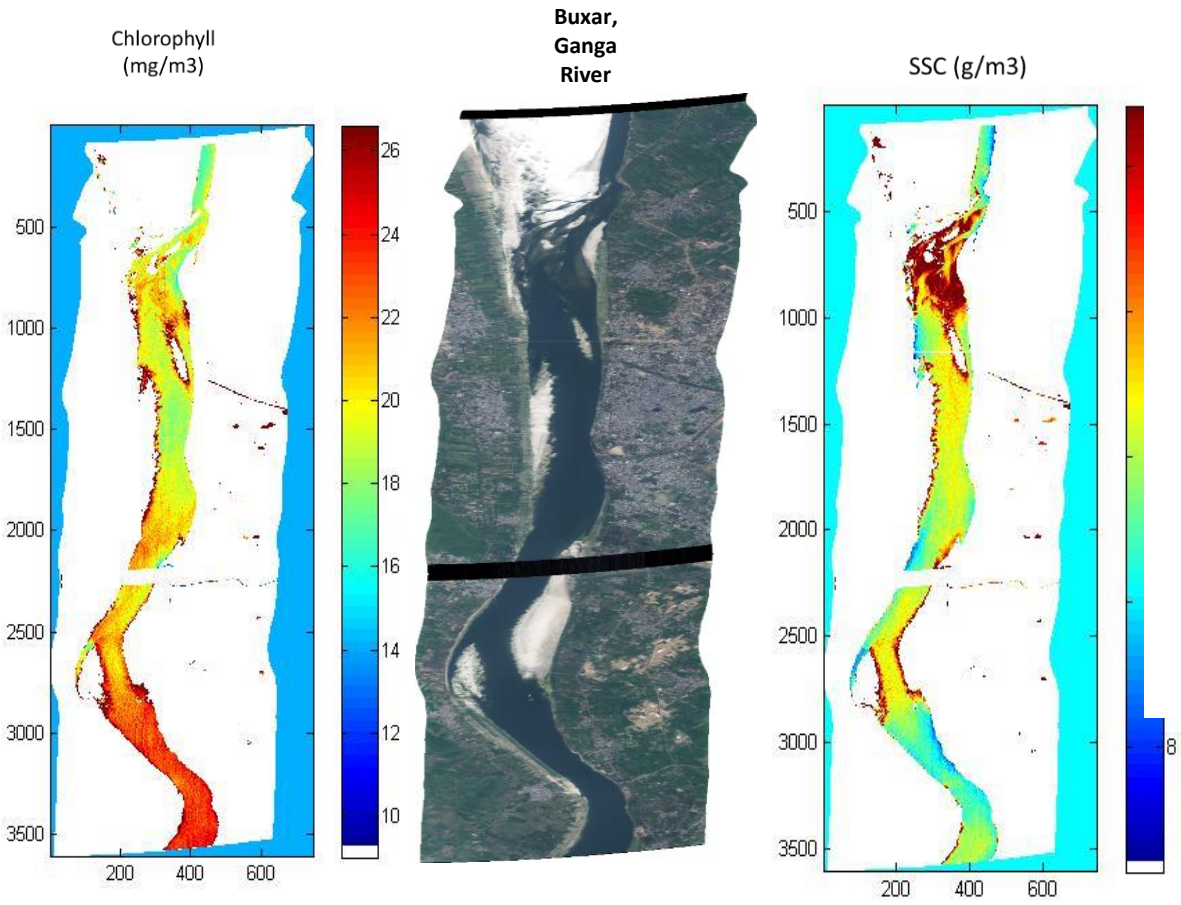


Spectral variability of different water types

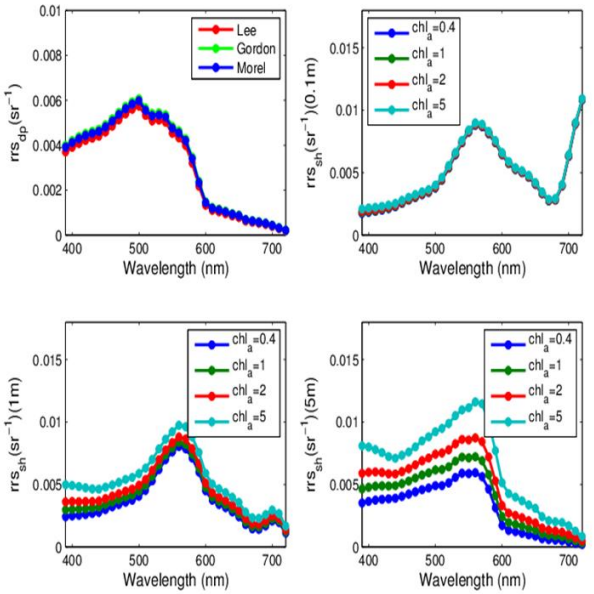
River Water Quality using AVIRIS Data over Ganga River, Buxar

Achievements

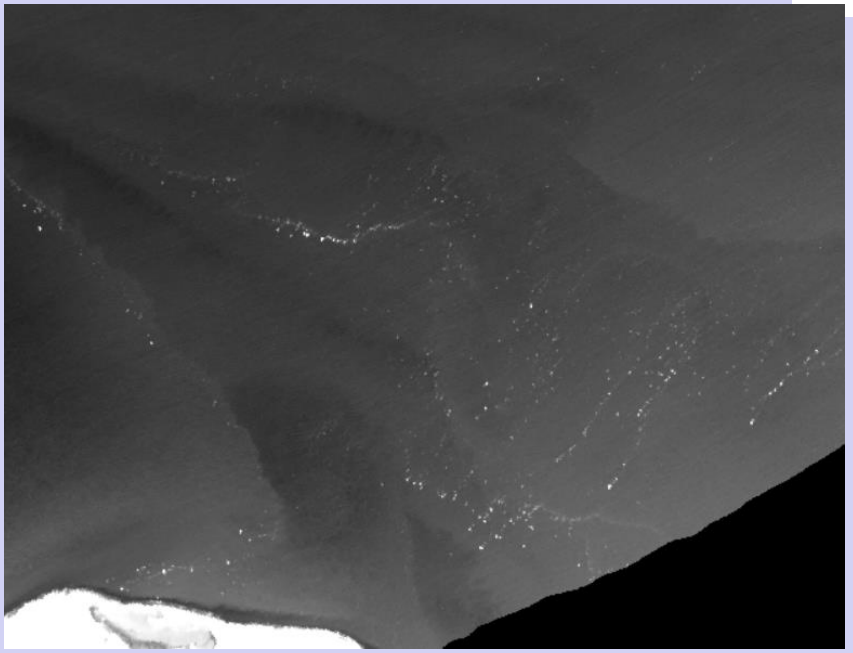
- Forward simulations were carried out to generate the synthetic database of remote sensing reflectance (r_{rs}) for all possible combinations of water quality parameters.
- Different type of bio-optical model were included in the simulations that take care of absorption and scattering properties of the water constituents along with the bottom substrate/depth.
- Semi analytical model was implemented for simultaneous retrieval of the water quality parameter and depth, from r_{rs} without taking any ground/prior information.
- Water quality maps were generated using AVIRIS dataset over Ganga River Buxar.



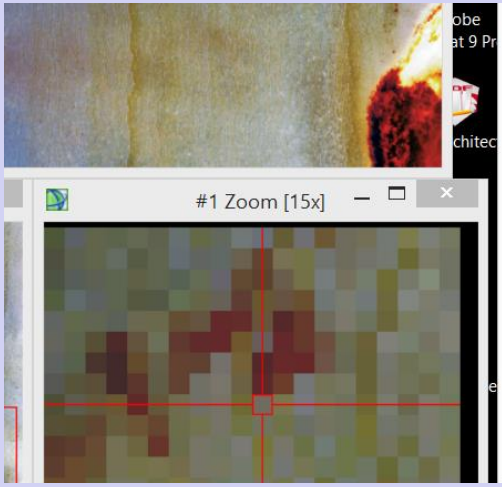
Variation of Simulated Remote Sensing Reflectance's with Depth

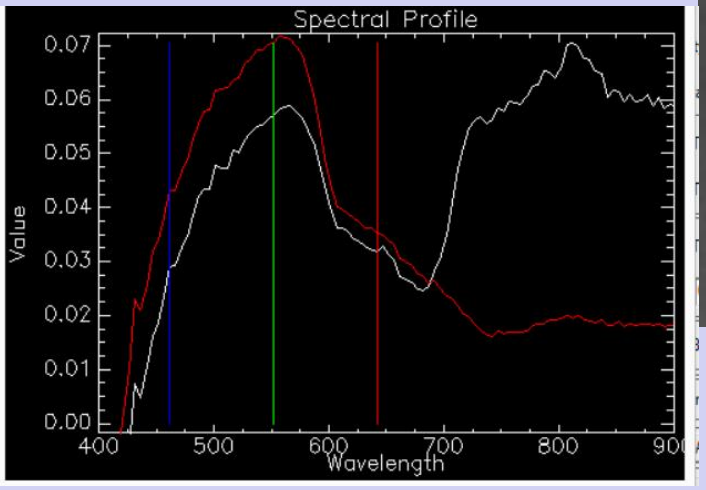


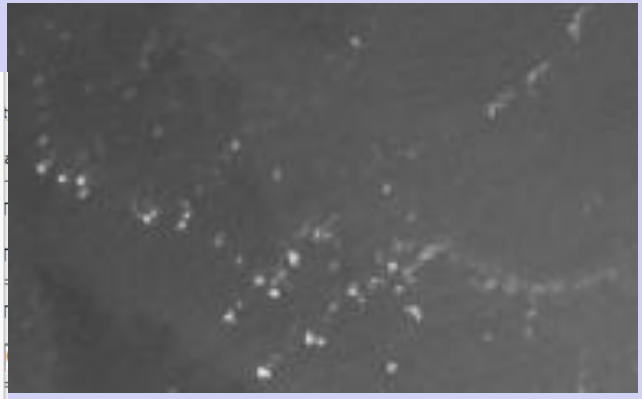
Sargassum Habitat over Pirotan Reef : AVIRIS NG data



Macroalgae Habitat around Pirotan

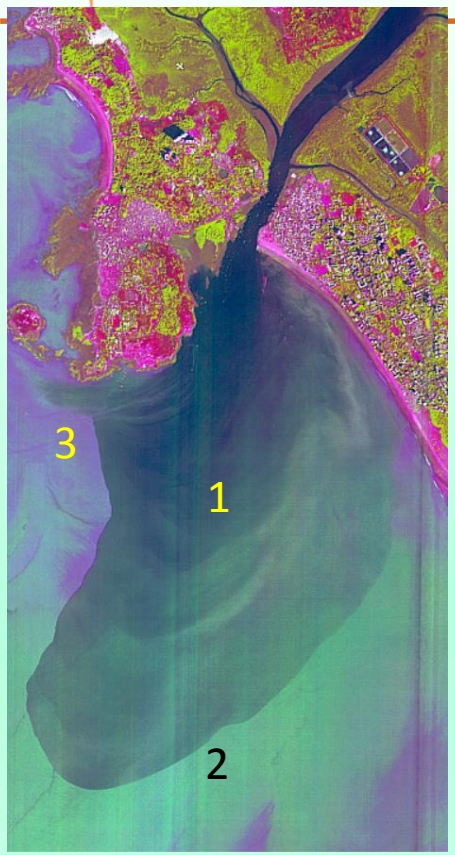




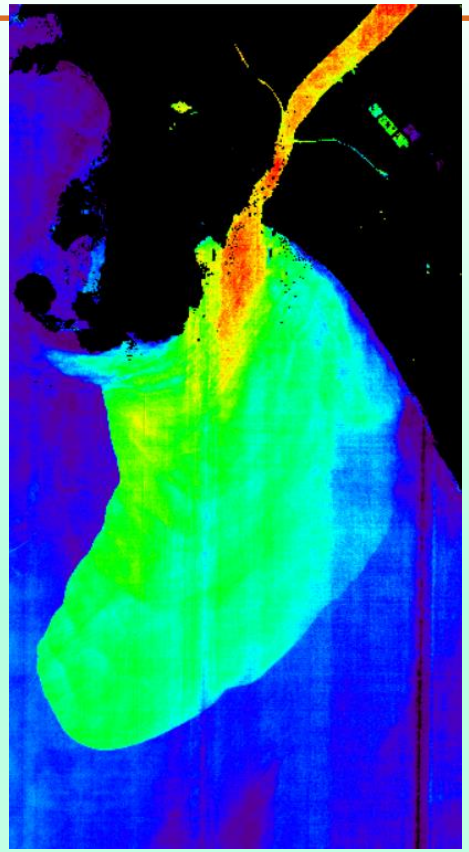


Floating Sargassum in the Gulf of Kachchh

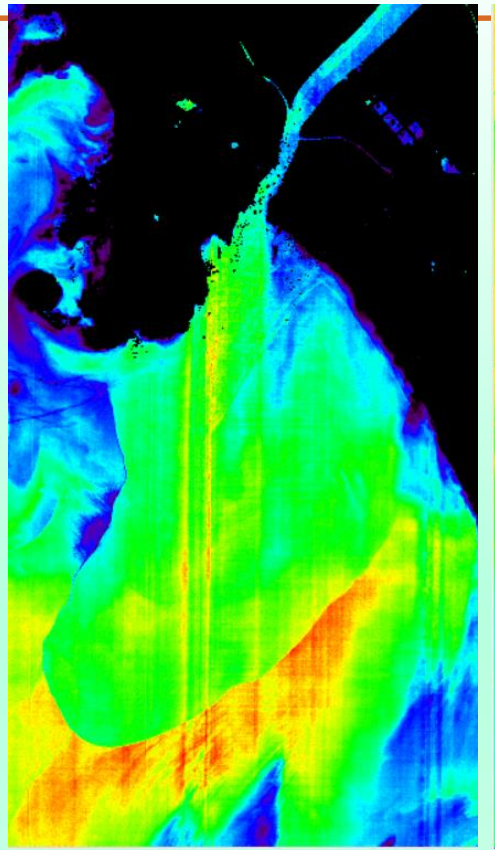
Potential of CARTO-2S data for Coastal Pollution dumps and Point Source discharge in Mumbai region



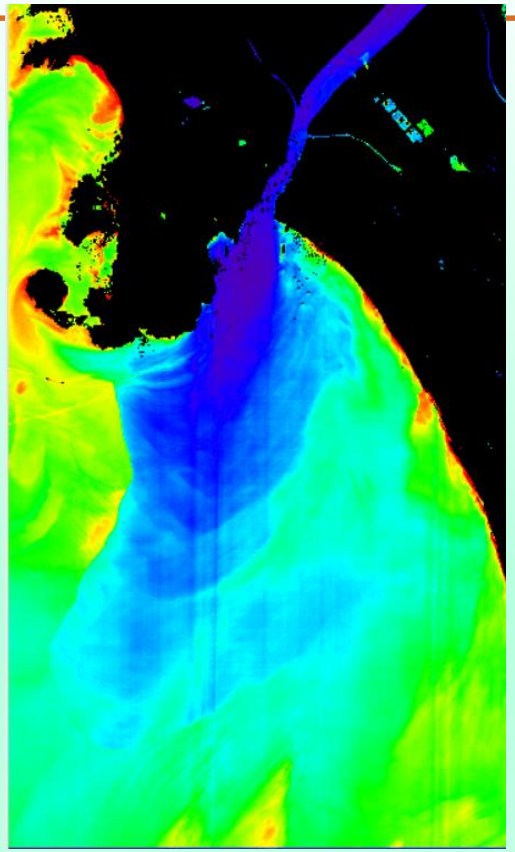
CARTO-2D PCA



Coloured Organic Matter



Chlorophyll-a



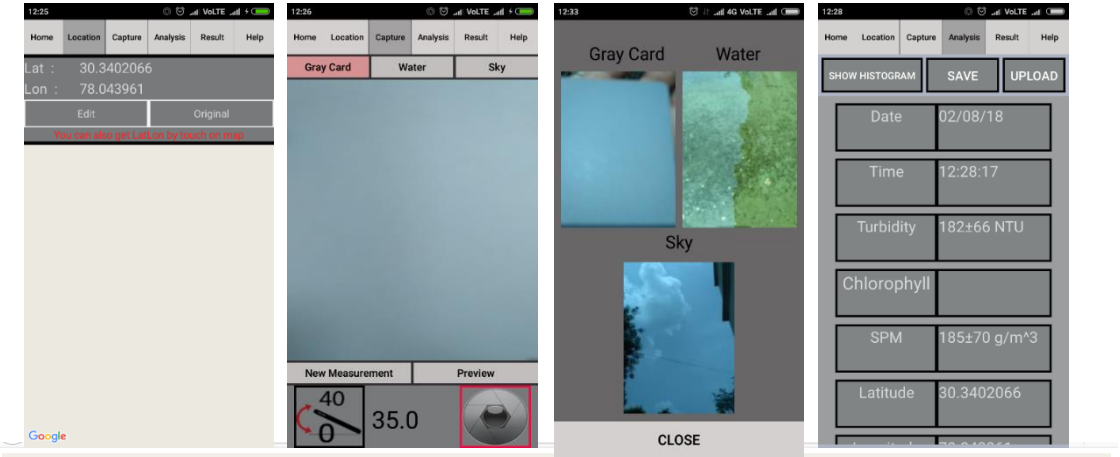
Inorganic Sediment

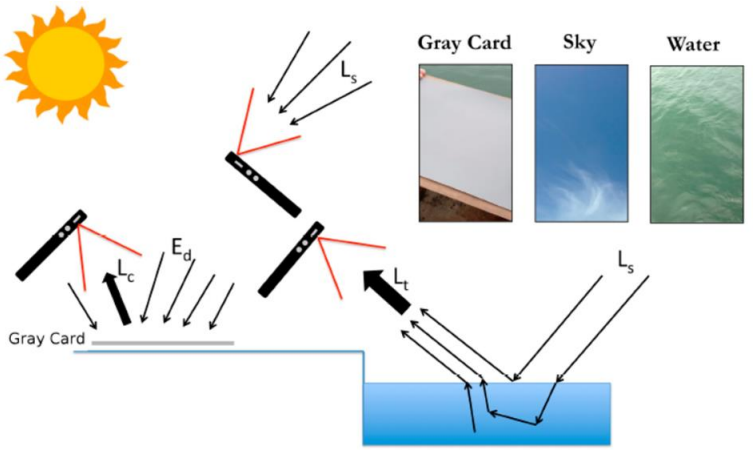
Optically active in-water constituents off Mumbai coast using CARTO-2S

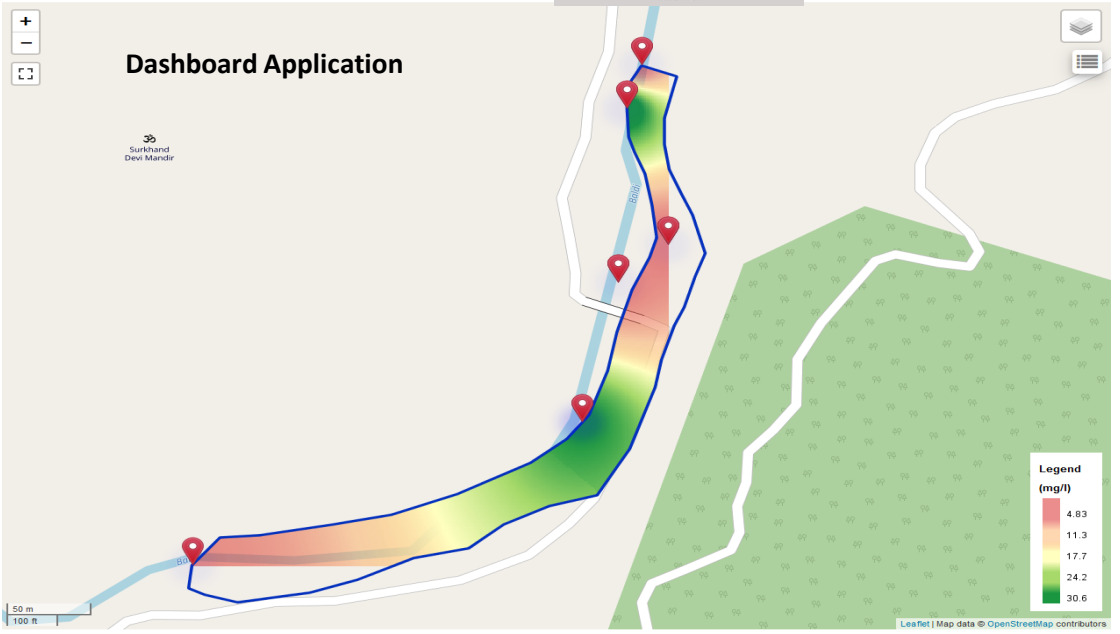
TURBIDITY-METER MOBILE APP

Principle: Mobile Phone camera is used by the user to measure

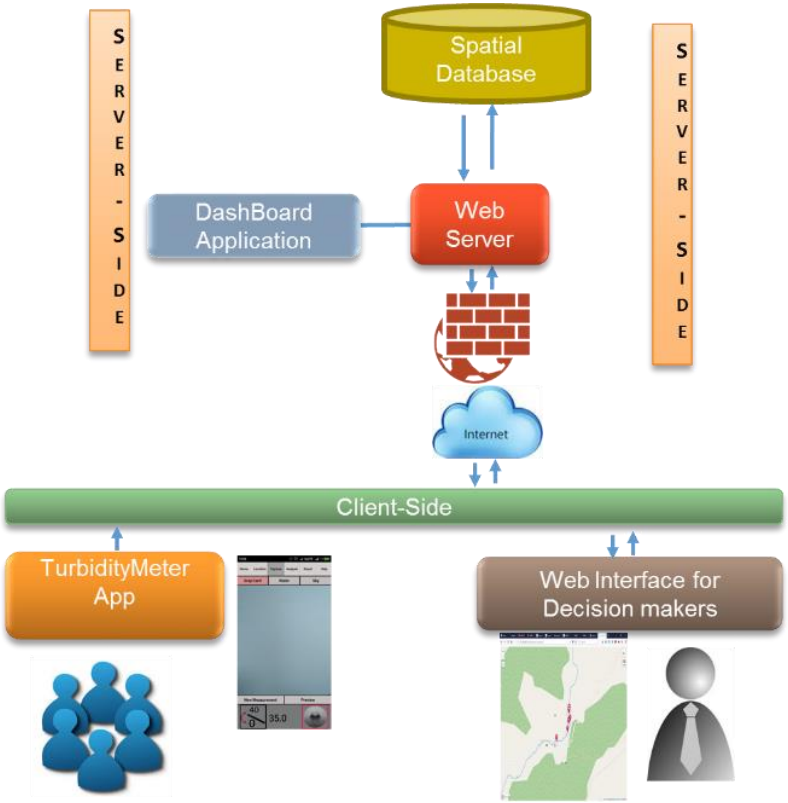
- how much light is emanating from the water surface (water image),
- correct that value for sun glint off the surface (sky image), and
- normalize it by the total incoming radiation (gray card image)



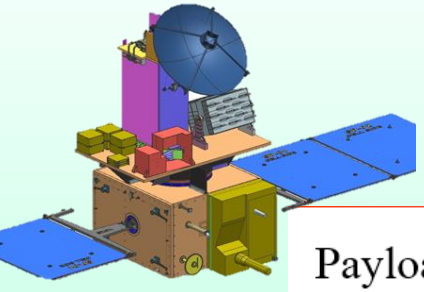




Architecture Diagram



Oceansat-3 Spacecraft



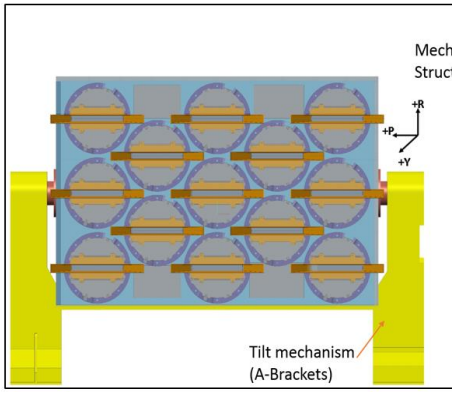
Mission Specifications

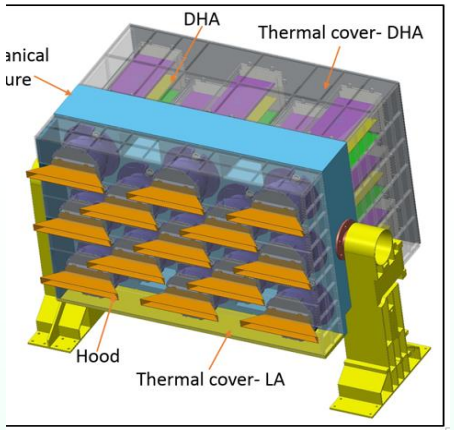
Payloads	:	OCM-3, Scat-3, SSTM-1 and Argos -4
Spacecraft Class	:	Standard I-1K bus
Mission Life	:	5 years
Spacecraft Mass	:	~1200 kg (Mainframe: 800 kg, P/L : 400 kg)
Power Generation	:	2414 W @ BOL; 2100 W @ EOL (with 1 S/F)
Spacecraft Load	:	450 W for Mainframe; 950 W for Payloads
Orbit type	:	Sun Synchronous Orbit (SSO)
Altitude	:	720 km or 735 km in case of marching orbit
Inclination	:	98.28^0
No. of orbits per day	:	14 + ½
Local time	:	12:00 Noon at descending node

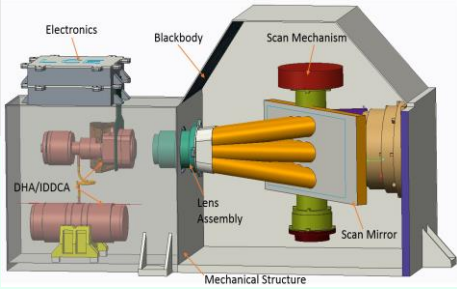
Oceansat-3 OCM & SSTM Instrument

OCM-3 Spectral Bands

Band No.	Central Wavelength	Application
B1	412 nm	Differentiate yellow substance from chlorophyll
B2	443 nm	Chlorophyll absorption maximum; low chlorophyll
B3	490 nm	Moderate chlorophyll
B4	510 nm	High chlorophyll; Total Suspended Matter (TSM)
B5	555 nm	Weak chlorophyll absorption
B6	566 nm	Phycoerythrobilins (PEB)
B7	620 nm	Turbidity in coastal Case 2 waters
B8	670 nm	Baseline for chlorophyll fluorescence
B9	681 nm	Chlorophyll fluorescence for high concentration
B10	710 nm	Baseline for chlorophyll fluorescence; extrapolation to visible bands for atmospheric Correction
B11	780 nm	Atmospheric correction; avoids O2 absorption Band
B12	870 nm	Atmospheric correction; good assessment of spectral scattering
B13	1010 nm	Atmospheric correction, aerosol – white foam discrimination







B1	**11 μm**	**Sea surface temperature detection**
B2	**12 μm**	**Sea Surface Temperature detection**

SSTM bands

Launch in early 2020

OCM Coffee Table Book

Available at IOCCG web site

http://ioccg.org/wp-content/uploads/2016/02/ocm-ocean-colour-atlas-2018.pdf

Capacity Building for Ocean Colour Science & Applications

Workshop cum training programme on "Coastal & Ocean Managem

January 29 - February 1, 2019 at IIRS Dehradun

- The workshop was designed for professionals and specialists from university, educational institutes, operational & research institutes and research scholars in Marine Science, Earth Science, Oceanography, Fisheries, Environmental Science and related fields.
- The aim of the programme was to provide participants an understanding of the scientific concepts associated with coastal and marine ecosystems, coupled with a practical knowledge of marine system management.
- 31 participants including professors, post-doc fellows and research scholars from different parts of the country attended the training programme.

International Training Centre for Operational Oceanography (ITC Oceans), INCOIS, Hyderabad

- Course on "Marine Phytoplankton- Optics, pigment and taxonomy" during March 25-29, 2019
- Course on "Coastal Vulnerability due to sea level rise and Storm Surges" during April 22-26, 2019

Thank You