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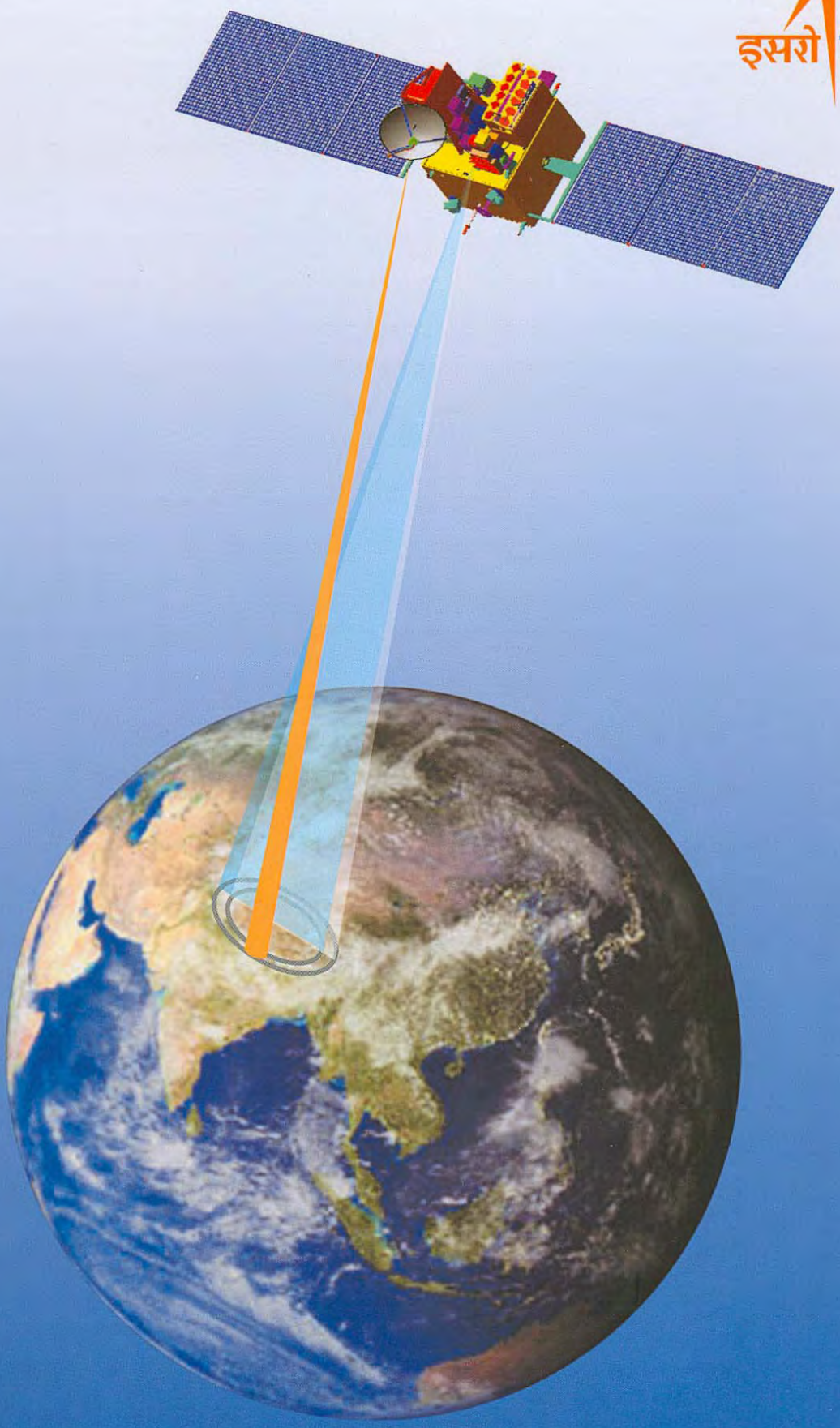


OCEANSAT-2

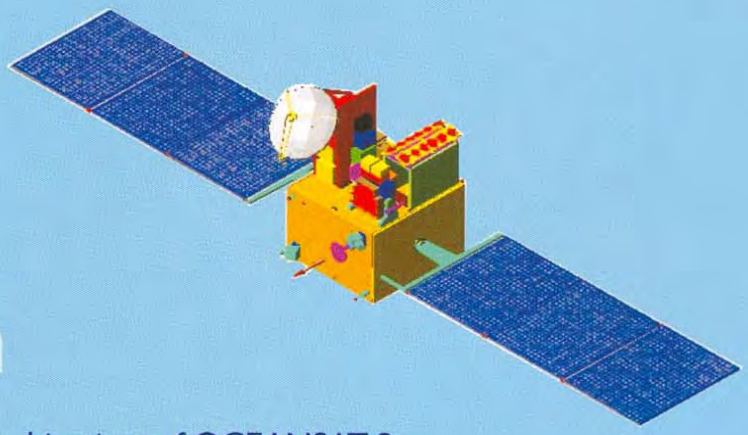
INDIAN SPACE RESEARCH ORGANISATION

OCEANSAT-2

Oceans, occupying almost 70% of the Earth's surface, greatly influence the global climate affecting the economy and day-to-day life of the people. Understanding the nature of influence of oceans, particularly its specific role in shaping the Earth's environment for life has been a scientific priority. Improved observations of the physical and biological parameters of oceans have, thus, become important for any meaningful study of the Earth's environment itself. The conventional means of these observations using ships, buoys and other in-situ methods is both difficult and expensive, and often not feasible at all. The synoptic observations from space-borne sensors, frequent enough to resolve the dominant scales of variation over the oceans in space and time, provide the most viable means for making these measurements over large tracts on an operational basis. In order to understand, predict and monitor these processes, it is very essential to make periodic and synoptic observations of various parameters like surface temperature, surface winds, humidity, precipitation, sea water salinity, bio-physical properties etc,. over the global oceans.

The Indian Remote Sensing (IRS) Programme of ISRO, keeping in view the immense potential benefits of space based remote sensing in the areas of natural resources survey, inventory and management has embarked upon the development of this technology in a major way using the orbiting satellites. While most of these missions were designed and deployed to cater to land based applications such as agriculture, hydrology, geology, forestry, urban planning, etc., the IRS-P4 (Oceansat-1) launched in May 1999 was the first dedicated mission for applications pertaining to ocean studies and meteorology. Two payloads, namely, Ocean colour monitor (OCM) and Multi-frequency Scanning Microwave Radiometer (MSMR) were flown on board IRS-P4. The data from OCM is being routinely used in its ' true' operational sense for identification of potential fishing zones in the Arabian sea and the Bay of Bengal.

Oceansat-2 Mission is envisaged to provide in-orbit replacement to Oceansat-1 and continuity of services for the operational users of OCM data as well as enhance the application potential in other areas. It will carry three Payload instruments, viz,. Ocean Colour Monitor (OCM), Ku-band Scatterometer (SCAT) from ISRO, India and a Radio Occultation Sounder for Atmospheric studies (ROSA) from the Agenzia Spaziale Italiana (ASI), Italy. Oceansat-2 is planned to be launched by indigenously developed PSLV launcher during 2008.



Mission

The primary mission objectives of OCEANSAT-2:

- To design, develop, launch and operate state-of-the-art 3-axes stabilised spacecraft carrying the Ocean Colour Monitor, Ku-band Scatterometer and the dual frequency Radio Occultation Sounder for Atmospheric studies (ROSA) with a mission life of at least 5 years.
- To develop algorithms for retrieval of parameters such as wind vector from Scatterometer; chlorophyll, suspended sediments, aerosol optical depth from Ocean Colour Monitor; characterise the lower atmosphere and the ionosphere using ROSA; and to supply data products operationally to the user community.
- To promote newer applications in the areas of ocean and atmospheric science.

Providing continuity of services to the Oceansat-1 being the primary consideration for the Oceansat-2 mission, the orbit is chosen identical to that of Oceansat-1. The major orbital parameters are

Altitude	–	720 km, near polar, circular
Inclination	–	98.28^{0}
Period	–	99.31 minutes
Equatorial crossing time	–	12 noon ± 10 minutes
Repetevity cycle	–	2 days

PAYLOADS

Ocean Colour Monitor (OCM)

OCM is an 8-band multi-spectral camera operating in the Visible Near-IR spectral range. It provides an Instantaneous Geometric Field Of View of 360 m and GSD of 236 m (along-track) covering a swath of 1420 km. Each spectral band will have an independent imaging lens assembly, a CCD linear array of 6000 pixels in the focal plane and the spectral band pass filter in front of the CCD. Out of the 6K pixels, 3730 pixels in the centre are used to cover the image field. Eight such assemblies are mounted on an Aluminium alloy structure with their optical axes parallel to each other. To avoid sun glint due to specular reflection from ocean surface, there is provision to tilt the OCM by ± 20 in the along track direction. The processing electronics consists of video processor, timing logic and interface circuits. On board calibration scheme using light emitting diodes mounted near each CCD is incorporated to study long term stability of the radiometric performance.

The configuration of OCM payload is identical to the one flown in IRS-P4, except for Band-6 and Band-7. For Band-6, the central wavelength is shifted from 670 nm to 620 nm to take advantage of the improved the reflectance from suspended sediments and for Band-7, the central wavelength is shifted from 760 nm to 740 nm to avoid Oxygen absorption.

Major Specifications of OCM

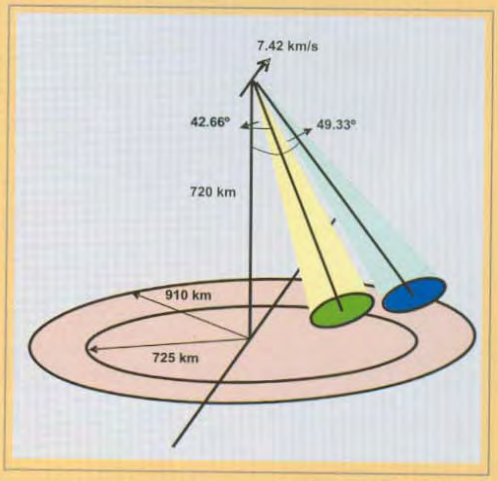
Parameters	Specifications
IGFOV	360 m X 236 m
Swath	1420 km
Repetitivity	2 days
No. Of bands	8
MTF at Nyquist	>0.26
Quantisation	12 bits
Along Track steering	± 20°
Weight	78 kg
Power	134 W
Data rate	20.8 Mbps

OCM Spectral Bands and their applications

Spectral bands	Wavelength Range (nm)	Applications
C1	402-422	Yellow substance absorption
C2	433-453	Chlorophyll absorption
C3	480-500	Chlorophyll and other pigments
C4	500-520	Turbidity and suspended sediments
C5	545-565	Chlorophyll reference
C6	610-630	Total suspended matter estimation
C7	725-755	Atmospheric correction
C8	845-885	Atmospheric correction/Aerosol Optical thickness

Ku-Band Pencil Beam Scatterometer

The Ku-band Pencil beam Scatterometer is an active Mmicrowave radar operating at 13.515 GHz. It consists of a parabolic dish antenna of 1 m diameter which is offset mounted with a cant angle of 46° with respect to the Yaw axis (earth viewing axis). This antenna is continuously rotated at 20.5 rpm using a DC motor with the scan axis along the +ve Yaw axis. By using two offset feeds at the focal plane of the antenna, two beams (Inner beam and Outer beam) are generated which will conically scan the ground surface. The inner beam operates with HH polarization and outer beam with VV polarization. The backscattered energy of the transmitted RF pulse from the ocean surface is received back at the antenna and after on-board 'range compression', it is digitized and transmitted to the ground. The normalized radar cross-section referred as Sigma-naught (s_o) is calculated from this echo data and the Wind vector is derived from using a Geophysical Model Function. The Scatterometer is operated in either of two modes – Processed data mode (which is the nominal mode) and Raw data mode. In processed data mode, the on-board processed (range compression, Doppler compensation and frequency binning) data will be continuously recorded in the solid state recorder and played back over any ground station, while in the Raw data mode the data is transmitted in Real Time.



Major specifications of the Scatterometer

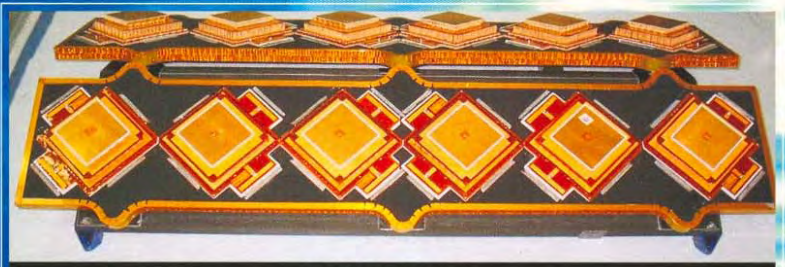
Parameter	Inner Beam	Outer Beam
Altitude	720 km	
Frequency	13.515 GHz	
PRF	200 Hz	
Wind speed range	4 to 24 m /sec.	
Wind speed accuracy	Better than 20 % (rms)	
Wind direction accuracy	20° (rms)	
Wind vector cell size	50 km x 50 km	
Polarisation	H H	V V
Swath	1400 km	1840 km
Elevation angle	42.62°	49.38°
Incidence angle	48.90°	57.60°
Footprint	26 x 46 km	31 x 65 km
Scanning rate	20.5 rpm	

Radio Occultation Sounder for Atmospheric studies (ROSA)

ROSA payload is a dual channel GPS receiver with two antennae and a receiver package. ROSA will be providing vertical profiles of atmospheric density, refractivity, pressure, temperature and humidity up to a height of about 30 kms. The radio-occultation antenna looking along the satellite velocity vector receives signals from the 'rising' GPS satellites near the earth horizon. These signals get refracted by the atmosphere and from the bending angle, the temperature and humidity profiles are derived. The Precise Orbit Determination (POD) antenna looking at the zenith of the satellite gives precise position of the receiver.

Major specifications of ROSA

Parameter	Specification
Frequencies of operation	LI 1560-1590 MHz L2 1212-1242 MHz
GPS codes used	C/A and P Code
Antenna gain	+ 5 dBi for navigation Antenna + 12 dBi for RO Antenna
Polarisation	RHCP
Horizontal resolution	<300 kms for Temperature & Humidity
Vertical resolution	0.3 km (Low Troposphere) 1-3 km (High Troposphere)
Accuracy	<1.0 K Temperature 10 % or 0.2g/kg Humidity
Input signal range	-127 to -133 dBm POD Antenna -130 to -148 dBm RO Antenna
Mass (kgs)	17
Power (w)	36 (standby); 38 (operation)



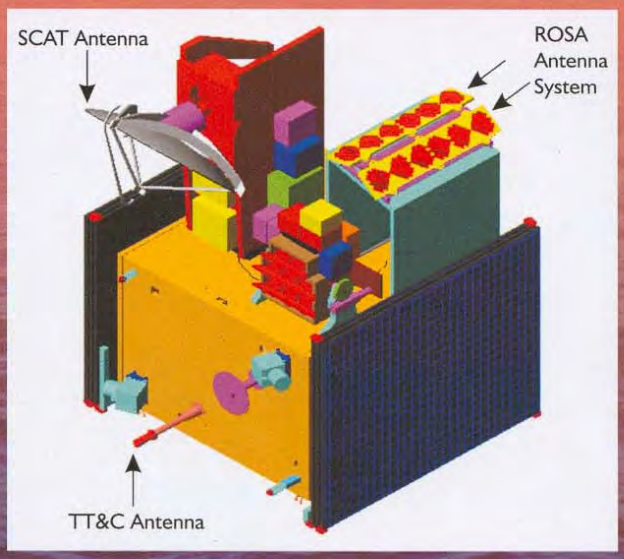
R O Antenna

Receiver

POD Antenna

SPACECRAFT CHARACTERISTICS

Oceansat-2 spacecraft mainframe bus is configured by deriving heritage from previous IRS missions as well as new sub-system designs, which are mission specific. The main structure is made up of CFRP composite cylinder with PSLV interface ring. Three deployment mechanisms are included – solar panel auto-deployment after separation from the launcher, OCM hold-down-release-tilt mechanism and SCAT antenna hold-down-release mechanism. Thermal control system is designed for 12 noon local time and uses both passive and active control elements. The power system is configured with solar array of same size as IRS-P6/P5 with Silicon cells. Two 24 AH Ni-Cd batteries will provide eclipse and peak load support. All the sub-systems are supplied with two raw buses of 28-42 V and DC-DC converters are used to derive required voltage lines. A centralized Bus Management Unit (BMU) designed with MAR31750 microprocessor provides the functions of AOCS, Sensor processing, Telemetry and Command, auto-temperature control and PSK demodulation of the TTC uplink carrier. Earth sensors, Digital sun sensors, tri-axial magnetometers, Four-π steradian sun sensors and gyroscope based Inertial reference unit will provide the platform attitude and rate measurements. The control actuators consist of 4 nos. of 5 NMS, 0.1NM torque reaction wheels mounted in Tetra-hedral orientation, two magnetic torquer coils and monopropellant Hydrazine thrusters. An 8-channel SPS system will provide both position and velocity, improving the overall orbit determination accuracy.



The payload data handling system is configured to transmit OCM and Scatterometer data on a single carrier with QPSK modulation at 42.45Mbps rate. The OCM data will be transmitted on I-channel and SCAT / ROSA data will be transmitted on Q-channel. An indigenous on-board Solid-state recorder of 64 Gbits capacity is used to record the on-board processed data of Scatterometer and ROSA continuously and OCM data as per requirement. The Payload telemetry data transmission system is configured using SSPAs and conventional X-band antenna.

MECHANICAL SYSTEM

Structure	CFRP - Aluminium honeycomb sandwich cylinder with Aluminium honeycomb panels	
Thermal System	Passive / Semi-active thermal control with paints, blankets, OSRs and closed looped auto temperature controllers	
Thermal Control	Payloads	15 ± 2° C for OCM
		5 – 45° C for Scatterometer
	Battery	5 ± 5° C
	Electronics	0 to 40° C
Mechanisms	Solar Panel Deployment	
	OCM hold down and release & OCM tilt SCAT antenna hold-down & release	

POWER SYSTEM

Solar panels	3 on either side, sun-tracking, 15.12 m^2
Solar array power	1360 W, EOL, normal to sun
Chemical Battery	2 x 24 AH Ni-Cd Batteries
Power Electronics	Two raw buses (28-42 V)

TTC SYSTEM

Telecommand	PCM/PSK/PM Modulation, 4 Kbps	
	Time tag command facility	
Telemetry	PCM/PSK/PM Modulation	
	4 Kbps (real time); 16 Kbps (playback)	
Transponder	Uplink frequency	2071.875 MHz
	Downlink frequency	2250 Mhz

AOCS

Sensors	Earth sensors, Digital Sun sensors, 4π Sun sensors, Magnetometer, Solar panel Sun sensors
Actuators	Reaction wheels, Magnetic Torquers, Reaction control thrusters
AOCE	Microprocessor based system
Pointing accuracy	+ 0.10° (Pitch & Roll)
	+ 0.15° (Yaw)
Positional accuracy	100-150 m (using SPS in autonomous mode)
Drift rate	< 3.0 x 10^{-4} deg/sec

DATA HANDLING SYSTEM

Data rate	42.4515 Mbps
RF System	QPSK Modulated Transmitter
X-band Frequency	8300 Mhz

SATELLITE MASS

~ 950 Kg

GROUND SEGMENT

The Ground segment elements for Oceansat-2 include Spacecraft Control Centre (SCC) at ISTRAC, Bangalore, payload data reception station at NRSA Shadnagar, data processing, data product generation and dissemination to users at NRSA, Balanagar, Hyderabad, data product software development at SAC, Ahmedabad and development of mission software, flight dynamics software and mission management at ISAC, Bangalore.

Telemetry, Tracking and Command Network Stations

The existing ISTRAC stations at Lucknow, Bearslake, Mauritius and Biak will be used for telemetry, tracking and command support under the control of SCC which will carry out mission operations, satellite health monitoring & analysis and payload operations scheduling / programming.

Data Reception Station (DRS)

NRSA Data Reception Station (DRS) at Shadnagar, Hyderabad with minor augmentation will receive the payload data both in the real time as well as playback from on-board memory. The received data will be separated instrument wise (OCM, SCAT, ROSA) and recorded on the Redundant Array of Independent Disk Storage (RAIDS) memory of the Data Acquisition and Quick Look Browsing (DAQLB) system. Quick-look display, Browse generation, Calibration analysis and Auxiliary data file (ADIF) generation will be carried out here. The data will be transferred to Balanagar on high-speed data link in off-line mode.

Data Processing and Products Generation

NRSA Data Processing System (DPS) at Balanagar, Hyderabad will be the nodal Centre for processing the data from Oceansat-2, with support from Space Applications Centre (SAC), Ahmedabad. The DPS system process the raw science data and generates the Ocean colour data products with inbuilt work order generation, online quality control, output media preparations, data quality evaluation and feedback to the mission operations. Associated development of mathematical formulations, geometric and radiometric look-up tables and their updation, associated software tools and geophysical model function for wind vector derivation from the Scatterometer data are part of the overall data products generation at different levels.

Oceansat-2 will provide two types of science data: Local Area Coverage (LAC) at 360 m resolution; and Global Area Coverage (GAC) at 1 km & 4 km resolutions.

Data Product dissemination

NRSA Data Centre (NDC) will carry out data dissemination to all interested users. User interface handling, archival, quality evaluation, catalogue generation etc., will also be carried out by NDC. Browse cataloging and on-line browsing will be part of the data quality checking.

The GAC products of 4 km resolution will be made available on the Internet. High-resolution real time LAC data can be received at ground stations of their visibility under an agreement with ISRO/Antrix Corporation. Onboard Solid State Recorder will be used to collect the GAC data on an operational basis, and limited LAC data of areas not covered by direct data reception stations. It is planned to provide the 4 km GAC data on the Internet, while the 1 km GAC data will be provided on selective basis to the users.

An Announcement of Opportunity (AO) for the global scientific community is also planned to be made prior to the launching of the satellite, and the specific products that could be made available for AO will be announced separately.

The planned Oceansat-2 data products are as hereunder:

Standard LAC data products of OCM:

Level 1B LAC	Radiance product
Level 1C LAC geometrically	Geo-referenced (Radiometrically and corrected) product
Level 2C LAC	Geometrically corrected geo-physical parameters Chlorophyll mapped product Sediment mapped product Aerosol optical depth at 865 nm Diffused attenuation coefficient (K-490 nm)

Standard GAC data products of OCM:

Level 1B GAC	Strip based/ Scene based Radiance product
Level 2B GAC	Corrected geo-physical parameters Chlorophyll mapped product Sediment Mapped product Aerosol optical depth at 865 nm Diffused attenuation coefficient (K-490 nm)
Level 3 GAC	Binned products (approximately 4 km resolution) Weekly Monthly Yearly

Standard products from Scatterometer:

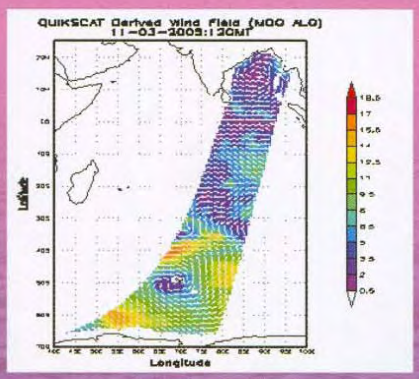
Level 2A	Sigma-0 product in swath grid with 50 km spacing
Level 2B	Wind product in swath grid with 50 km spacing
Level 3W	Global wind product with grid spacing 0.5^{0}
Level 3S	Global sigma-0 product with grid spacing of 0.5^{0}

APPLICATIONS

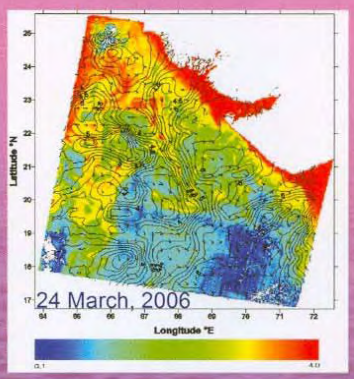
Ocean Colour Monitor (OCM) applications are in the fields of biological oceanography (assessment of marine resources, primary production estimates, Potential Fishery Zone and related modelling, algal blooms detection in coastal areas); geological oceanography (fluvial fluxes in coastal and marine environment); bio-geo-chemical cycles, and transport of aerosols in the atmospheric boundary layer.

Global Scatterometer measurements have wide ranging applications in meteorology (monsoon onset, tropical cyclones, improved medium range weather forecasting); physical oceanography (monitoring and prediction of ocean state parameters); land applications (large scale soil moisture estimation, vegetation classifications and growth assessment); and studies related to polar ice characterisation.

ROSA data will be useful in the area of meteorology/climatology (temperature and humidity profiles); Space weather (electrons density profiles in the ionosphere); Solid Earth Physics (POD).



Wind Vector



Potential Fishing Zone Map

OCEANSAT-2 & BEYOND

The India EO programme envisages thematic series of IRS satellites on a continued and assured basis. Under the Ocean and Atmospheric category, the Oceansat-2 will be followed-on by Oceansat-3 with improved capabilities around 2011-12 time frame.

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