

CALIBRATION AND VALIDATION OF IRS SENSORS

PAST,PRESENT AND FUTURE

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Outline of Presentation

- Brief History
- Work so far...
 - In-flight Characterization Of TES PAN Sensor On Chharodi Site
 - LISS4 sensor performance parameter on Chharodi test site
 - High Resolution Sensor Specific Parameter Evaluation Using Cartosat-1 Imagery
 - Calibration and validation of Ocean Color Monitor-1 sensor onboard Oceansat-1
- Future

Brief History

Satellite	Sensor	Spatial Resolution	Duration
IRS-1B*	LISS-2	36.5m	1996
IRS-1C	LISS-3/PAN	23.5m/5.8m	1996-2003
IRS-1D	LISS-3/PAN	23.5m/5.8m	1997-2003
TES	PAN	1m	2001-2004
IRS-P6 (Resourcesat-1)	LISS-4	5.8m	2003-2006
CARTOSAT-1	PAN-A/PAN-F	2.5m	2005-
CARTOSAT-2	PAN	0.8m	2006-

* ISRO/DLR Joint calibration exercise

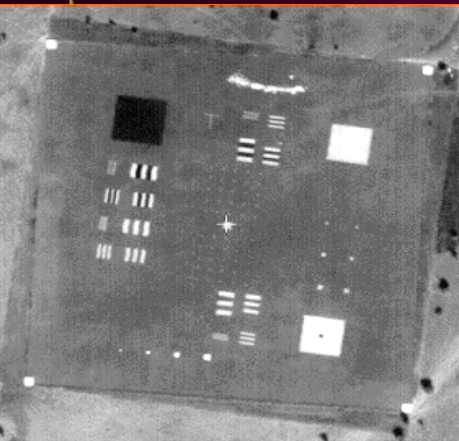
Brief History

Site Name	Target Features	Calibration Parameters
Kurukshetra	Man made Water Tank	Spatial Characterization
Jaisalmer	Desert Sand	<ul style="list-style-type: none"> •Absolute Calibration •Inter-sensor comparison
Ahmedabad (Chharodi)	300mx300m Calibration site with deployable artificial targets	<ul style="list-style-type: none"> •Absolute Calibration •Spatial Characterization •Inter-sensor comparison

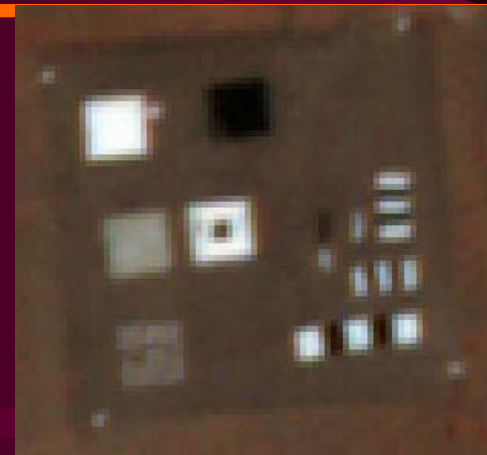
CLOTH TARGET DEPLOYED ON SRC GROUND

(Inset shows IRS-1C PAN image)





So Far....



TES PAN SENSOR

LISS4 MULTISPECTRAL



CARTOSAT-1 AFT

CARTOSAT-1 FORE

CALIBRATION AND VALIDATION OF IRS
SENSORS

CHHARODI CALIBRATION SITE (CCS)

- Located at only 35km (1 hour... Driving) distance from Space Applications Centre (SAC)
- 300m by 300m fenced for restricted movement
- Earmarked by four concrete platforms for ease in identification from image
- Black soil reduces contribution from background on deployed artificial targets
- Maintained flat through annual maintenance contract





The Instruments

- Analytical Spectral Devices UV/VNIR Spectroradiometer
- Calibrated Spectralon as White reference
- Microtops Sun Photometer
- Microtops Ozonometer
- Temperature Logger
- Relative Humidity logger
- Leica Laser Locator for target alignment

INSTRUMENTS FOR RADIANCE/IRRADIANCE AND ATMOSPHERIC PARAMETER MEASUREMENTS



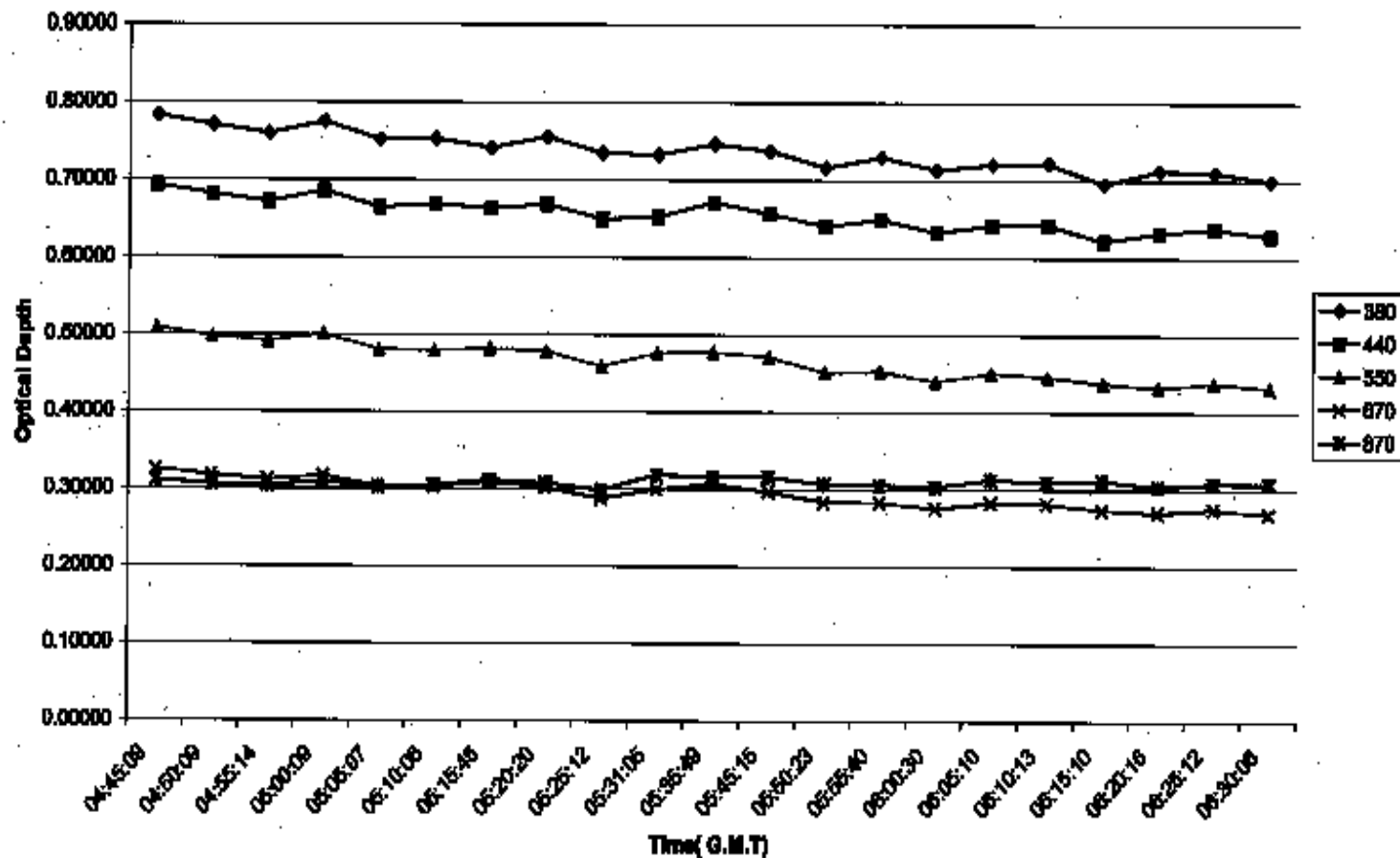
Radiometric Parameters

- Target Radiance
- Target reflectance factor

Atmospheric Parameters

- Downwelling Solar Irradiance
- Global Solar Irradiance
- Aerosol Optical depth
- Ozone Optical Depth
- Temperature
- Relative Humidity

Aerosol Optical Depth on 22-Dec-03 Over chharodi



Spatial Characterization Parameters

- Point Spread Function (PSF)
- Modulation Transfer Function (MTF)
- Effective Resolution Element (ERE)
- Radiometrically Accurate IFOV (RAIFOV)
- Square Wave Response (SWR)

Work so far...

- In-flight Characterization Of TES PAN Sensor On Chharodi Site (36 slides)
- LISS4 sensor performance parameter on Chharodi test site (13 slides)
- High Resolution Sensor Specific Parameter Evaluation Using Cartosat-1 Imagery (20 slides)
- Calibration and validation Ocean Color Monitor-1 (OCM-1)

Future

1. Establishing the present test site, with following ideal requirements*, as a benchmark test site for high resolution sensors:

- History of data records
 - In-situ as well as satellite data from year 2000
- Large flat homogenous area
 - Maintained flat through Annual maintenance contract

* EO sensor calibration using GIANTS, P M Teillet et al

Future

- High percentage of clear skies and dry conditions
 - Site located in tropical region with high percentage of clear sky and dry conditions
- Primarily bright targets but a few low reflectance targets as well
- Nearly lambertian and nearly flat spectral reflectance
 - Artificial targets with nearly lambertian high to low spectrally flat reflectance values

Future continued...

- Year round availability of test site but with controlled human and animal disturbance
 - Site is available under MoU up to year 2016 and is fenced from all sides for ‘controlled’ human and animal disturbance

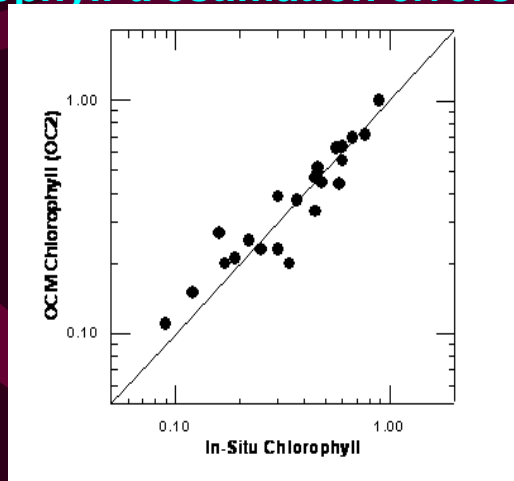
2. Create an organizational setup for collaboration with global cal/val groups
3. Collaboration to include sharing of data as well as methodology and outcome
4. Cross calibration of sensors using mutual sites
5. Development of target design with ISO certification

Future Missions

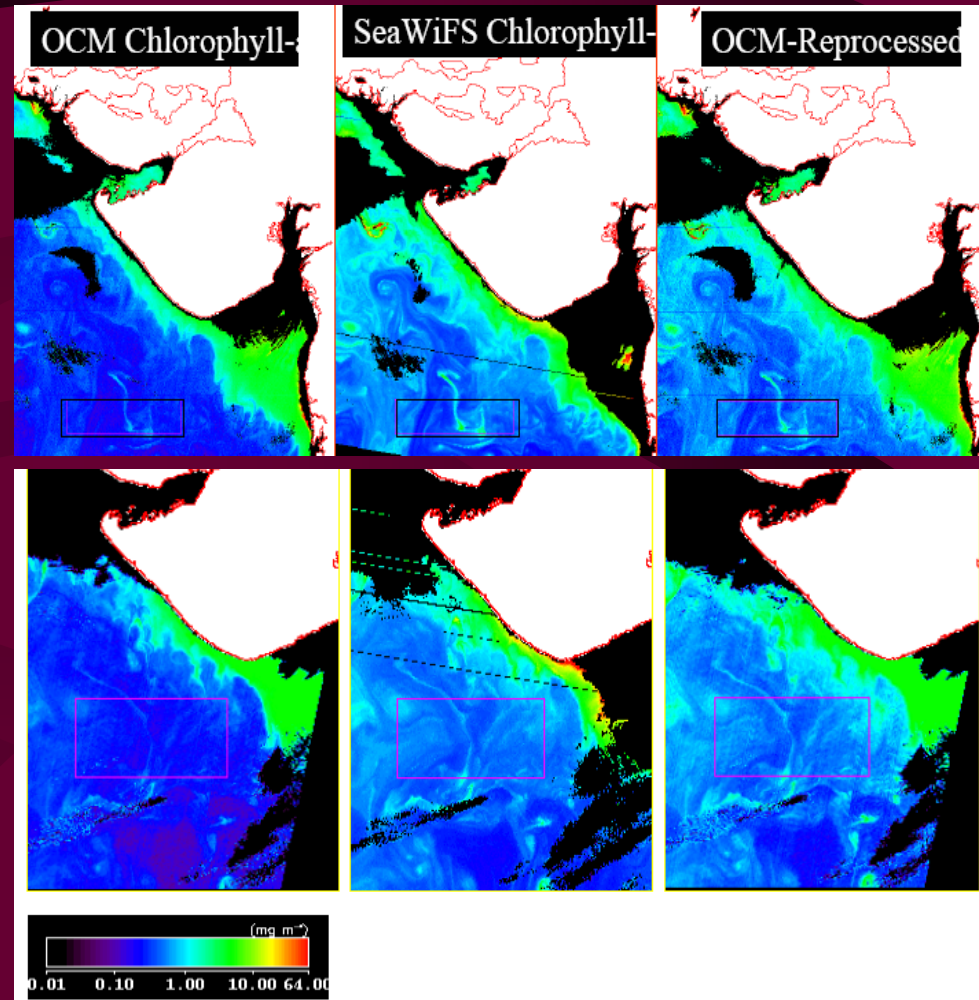
- Oceansat-2
- Resourcesat-2
- INSAT

OCM-1 Cal / Val Experiments

- Inter sensor calibration of OCM & SeaWiFS
- Vicarious calibration of OCM was done
- Validation of derived products using *in-situ* measurements
- Chlorophyll-a estimation errors within 30%



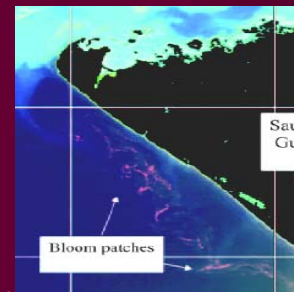
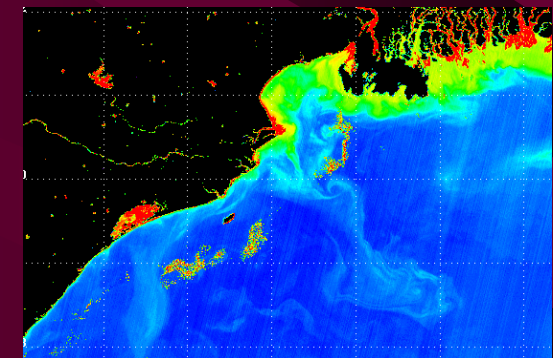
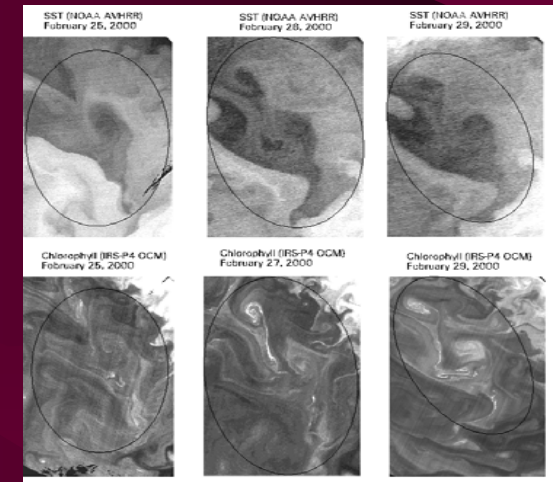
Validation of OCM Chlorophyll



SeaWiFS-OCM inter-calibration

Applications of OCM data

- Potential yield of marine resources using primary production modeling
- Synergistic use of surface winds, ocean-colour and SST for enhanced PFZ
- Species specific fish forecast
- Fluvial fluxes in coastal environment
- Algal blooms
- Dust Aerosol Transport



CALIBRATION AND VALIDATION OF IRS SENSORS

Oceansat-II Specifications

Payloads	Ocean Color Monitor-II and Ku-band Scatterometer
Repetitivity cycle	2 days
Altitude	720 km
OCM-II Features	
Swath	1420 km
FOV	360m
Bands	8 (400nm- 885nm)



OCEANSAT-2 OCM Data products

LEVEL-1 Product: Basic Data Products

- L1A RAW Products (Internal Use Only & DQE)
- L1B Radiance Product
- L1C Radiometrically and Geometrically corrected

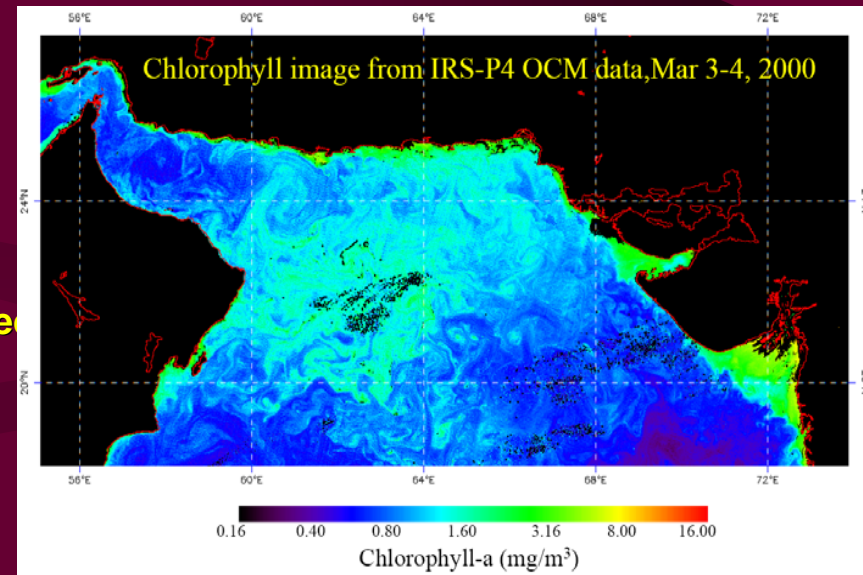
LEVEL-2 Product: Geo-Physical Parameters

- Chlorophyll-a concentration
- Total Suspended Matter (TSM)
- Diffused Attenuation Coefficients (K_d -490 nm)
- Aerosol Optical Depth (AOD) at 865 nm

LEVEL-3 Product: Binned Products (4 km)

- Weekly
- Monthly
- Yearly

Products supported in
HDF 4 format



OCEANSAT-2 AO

- **OCEANSAT-2 AO for international users was announced in January 2008**

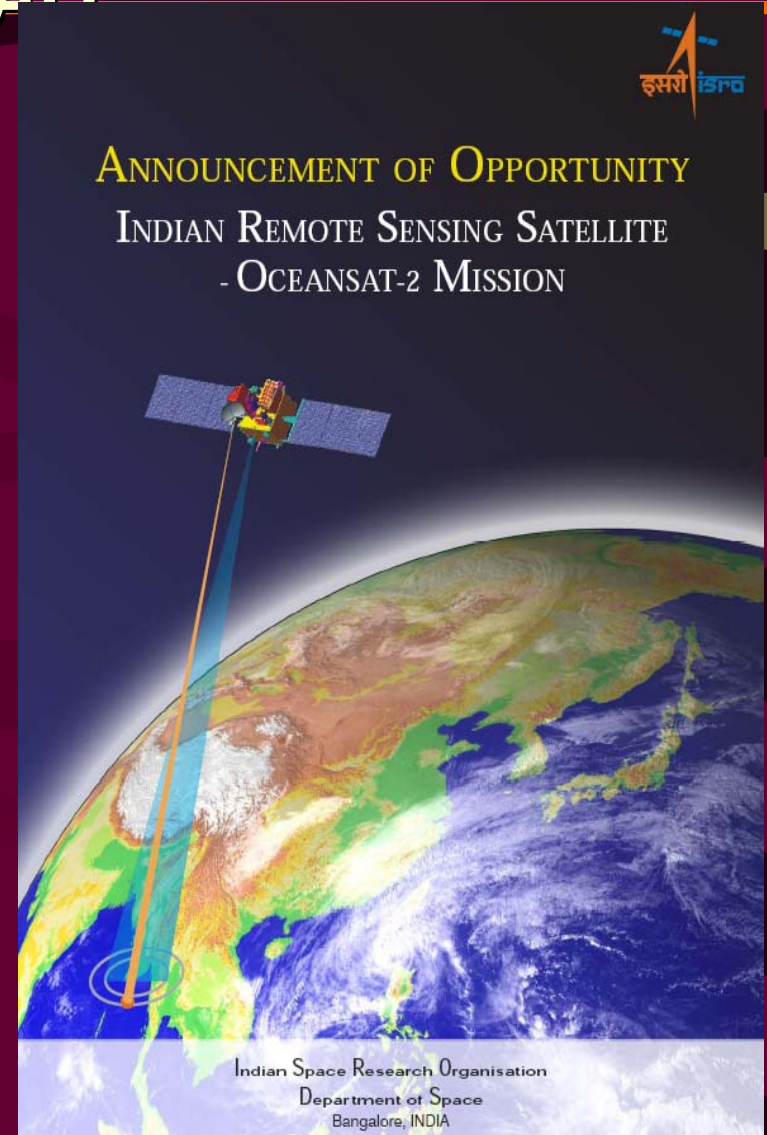
- **Broad research areas are**

- Retrieval algorithms and Calibration & Validation
- Application of ocean colour and Scatterometer data for ocean & atmospheric research
- Synergistic studies using multi-sensor data to understand processes
- Assimilation of geo-physical parameters in models

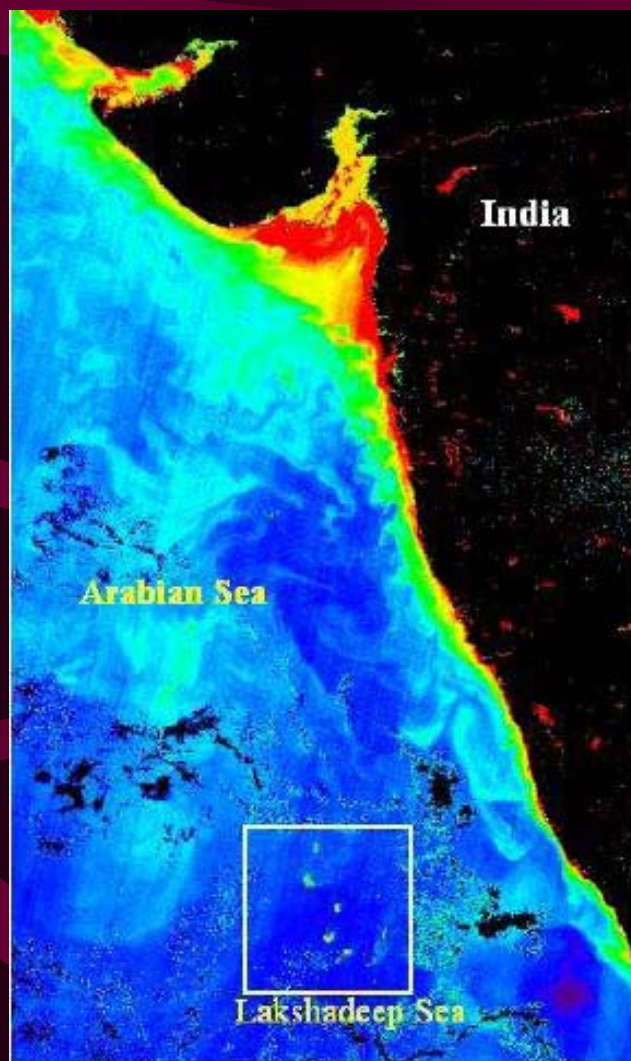
- **Details can be obtained on ISRO web site**

(www.isro.gov.in)

Data Product Dissemination: NRSA Data Center (NDC) will carry out data dissemination to users. GAC product of 4 km resolution will be made available on the Internet.



Site and Instrument Specifications



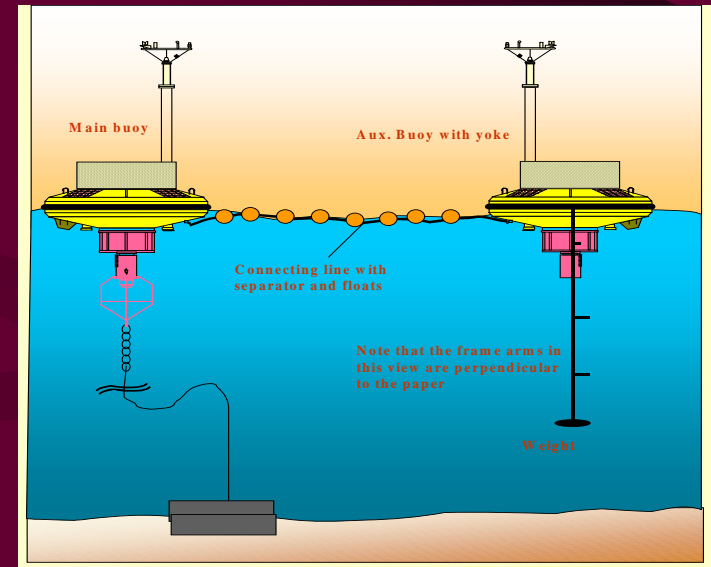
Site Location	30 km Off Kavaratti island
Buoys Features	2.2m diameter for instrument installation
	OPTICAL and MET buoy
	Buoys Connected by semi-rigid connector
Sunphotometer	Located on Kavaratti Island



Ref: Dr. Shailesh Nayak, POGO-8 meeting, Qingdao, Jan 2007

Cal & Val Experiments

- A Permanent Cal-Val site is being set up near Kavaratti in Lakshadweep Sea
- Optical buoy is deployed to collect hyperspectral observations of light, chlorophyll-a, temperature and aerosol optical depth
- This *in-situ* data sets will be used for vicarious calibration of ocean colour sensors
- Extensive Ship campaigns will also be organized for validation of geophysical data products.
- Inter-sensor calibration with contemporary missions like MODIS, MERIS etc
- Lunar calibration of OCM-2



OCEANSAT-II SCATTEROMETER CALIBRATION & VALIDATION

Raj Kumar

Space Applications Centre, (ISRO)



CALVAL ACTIVITIES

- CALIBRATION OF σ^0
- VALIDATION WITH
 - IN-SITU DATA (BUOYS, AWS, SHIPS)
 - INTER-COMPARISON WITH
 - SATELLITE DATA (QS, ASCAT, SSM/I, JASON)
 - NUMERICAL MODELS
 - ECMWF, NCMRWF

RELATIVE CALIBRATION

- **REFERENCE TARGETS (HOMOGENEOUS)**
 - **AMAZON FOREST**
 - **SAHARA DESERT**
 - **HOMOGENEOUS INDIAN LAND MASS**
 - **POLAR ICE**
 - **RANGE OF σ^0**

PLAN FOR RELATIVE CALIBRATION

PRE-LAUNCH PHASE

QS BYU PRODUCT σ^0
4 KM or 22 KM (2 YEARS)

SELECT HOMOGENEOUS
SITES

TEMPORAL VARIATIONS

DIURNAL VARIATIONS

MONITORING for ASC &
DES PASSES

GENERATE STATISTICS

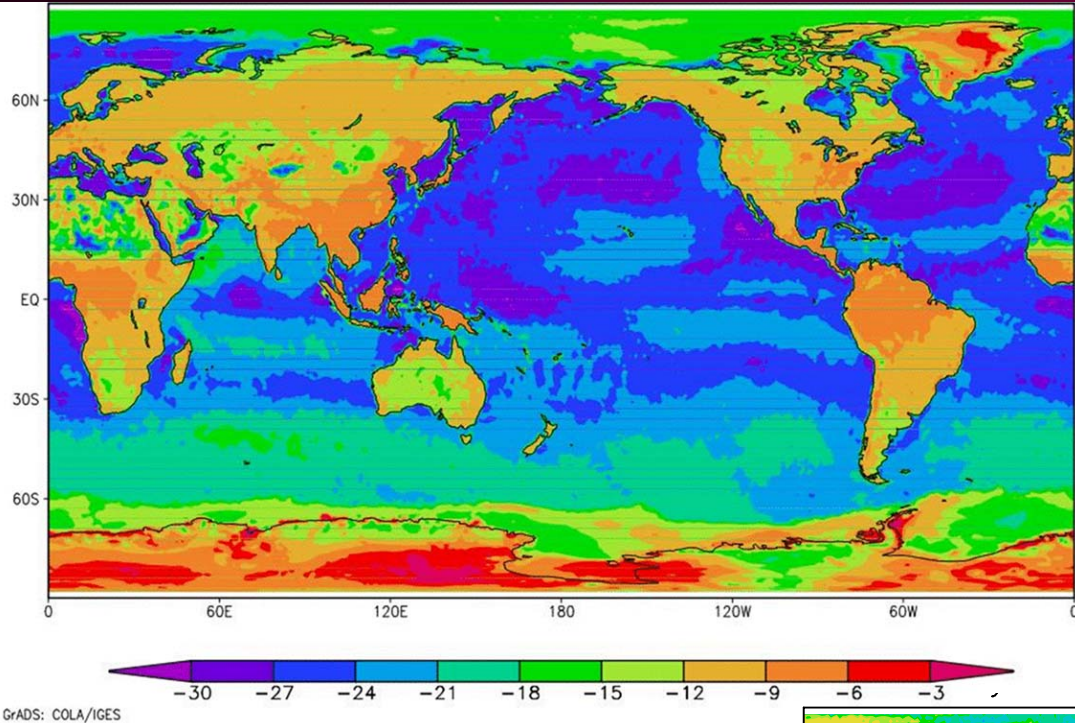
POST-LAUNCH PHASE

OS-2 SCAT LEVEL-1B DATA

SELECT SAME SITES

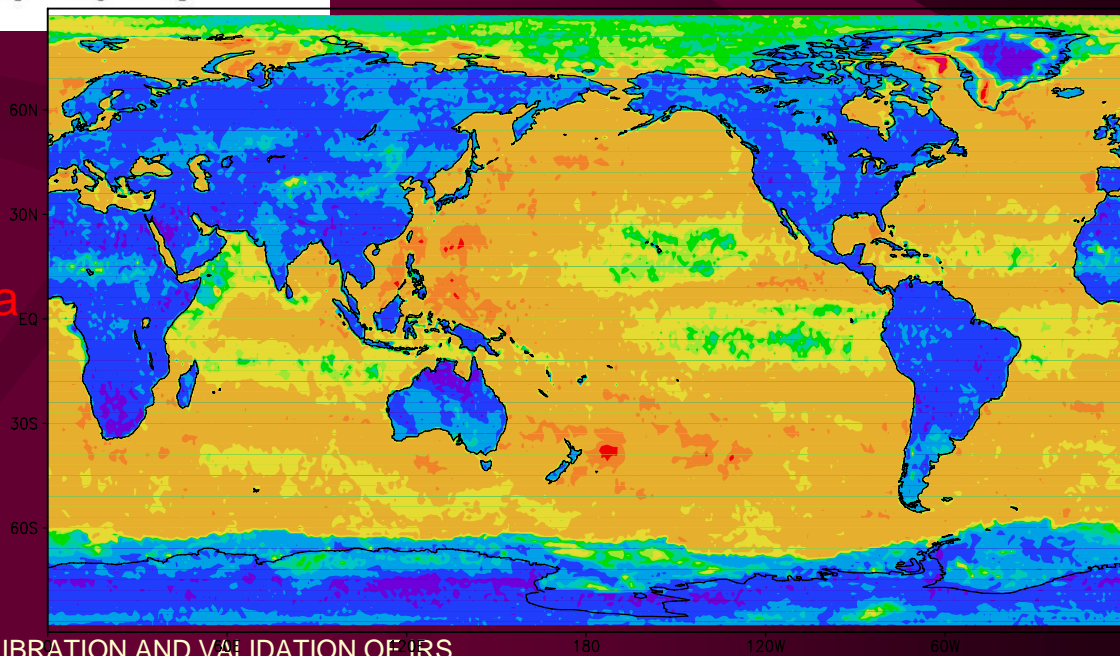
STUDY VARIABILITY

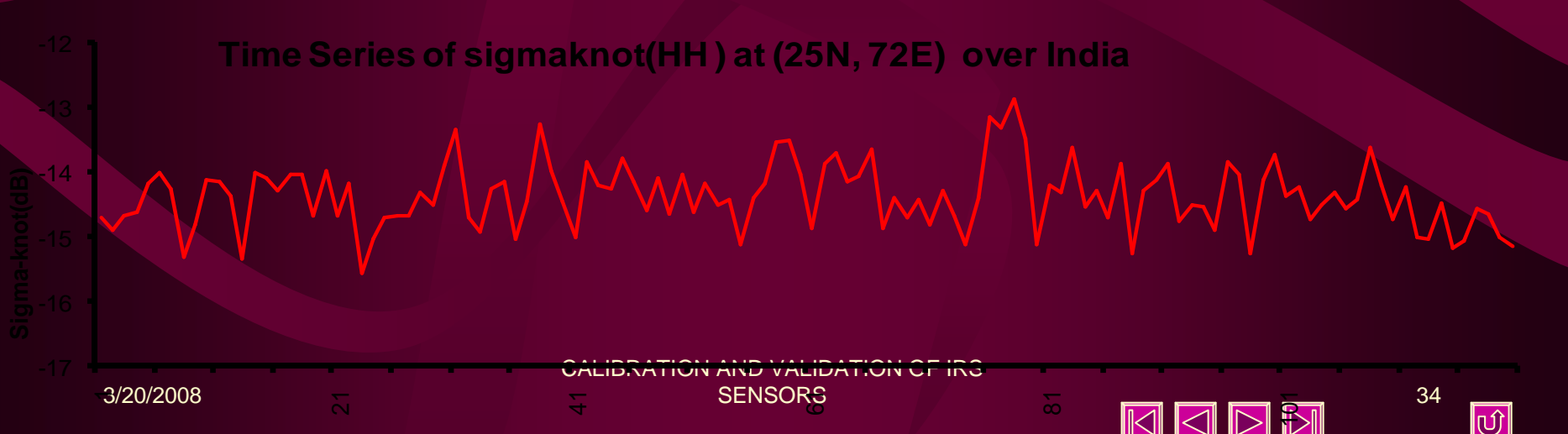
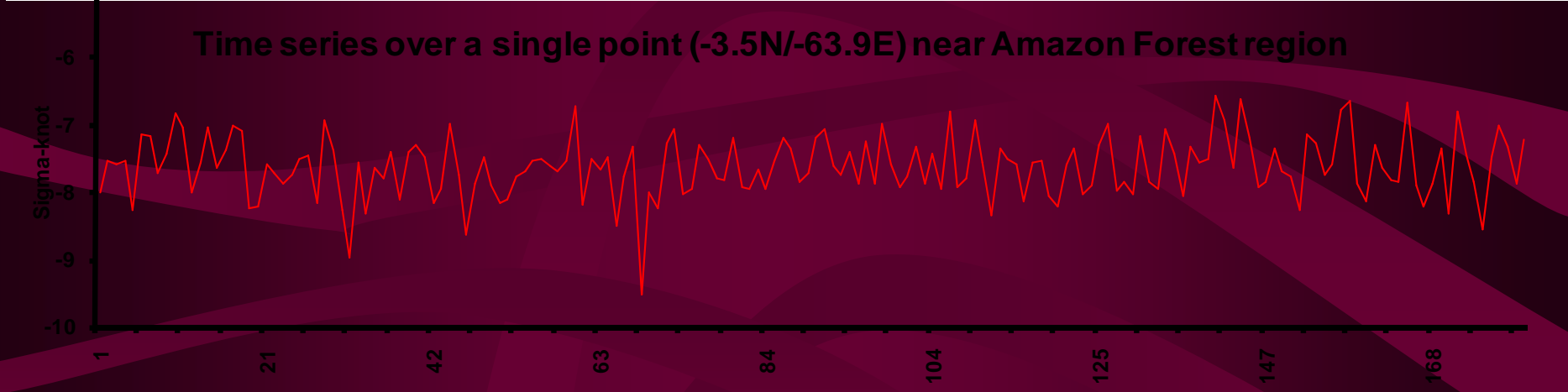
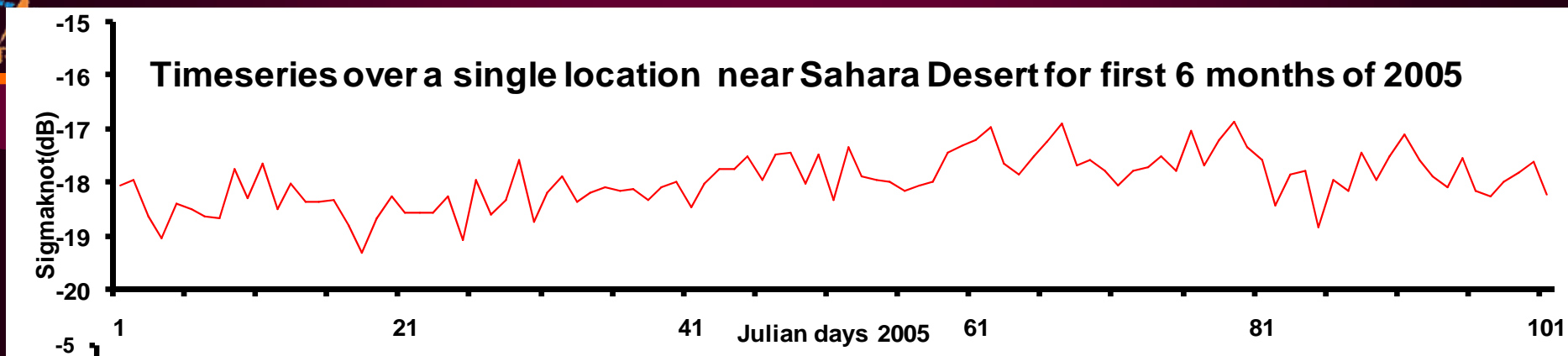
COMPARISON WITH QS
VARIABILITY



Monthly Average of Quikscat Sigma
for July 2005

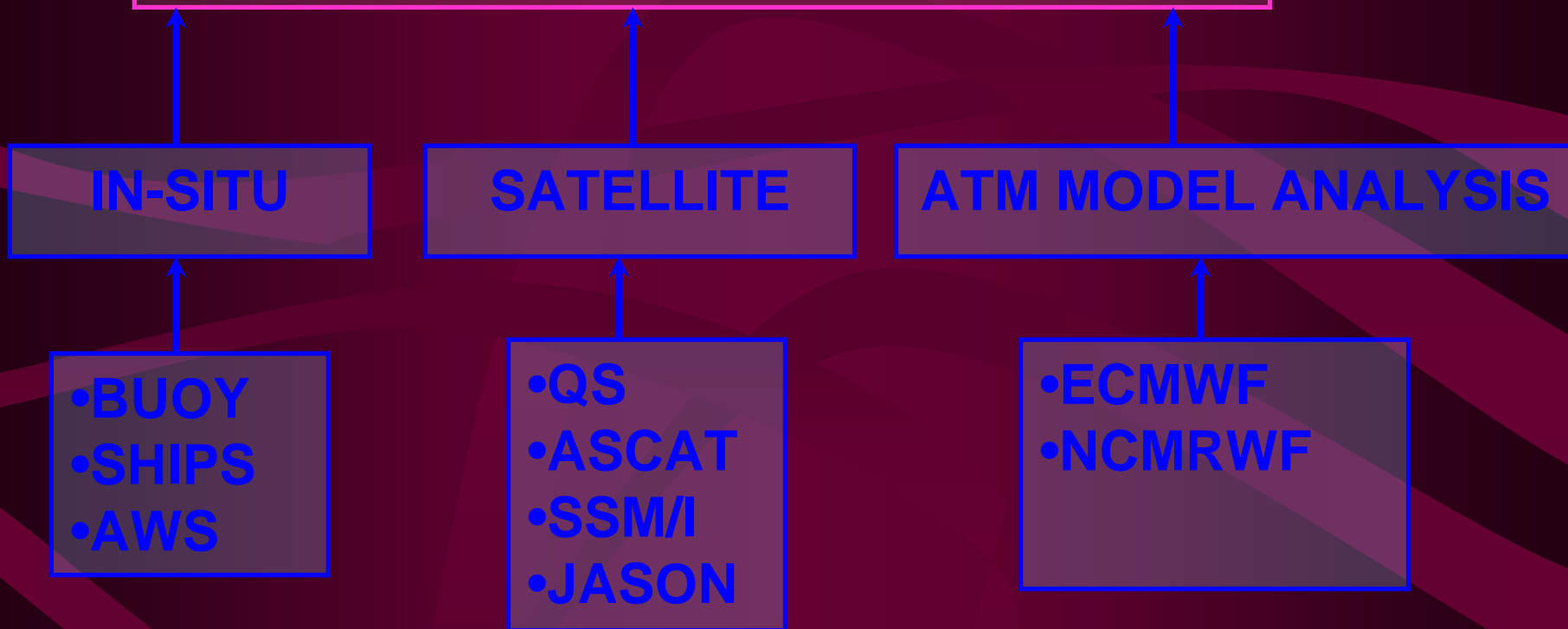
Monthly Std Dev of Quikscat Sigma
for July 2005





VALIDATION OF OS-2 WINDS

QS & OS-2 LEVEL-2B DATA



VALIDATION - INSITU

PRE LAUNCH ACTIVITY WITH QS

QS LEVEL-2B DATA
0.25° (2005-2006)

IDENTIFY BUOYS/AWS/SHIPS

QUALITY CHECKS

HEIGHT CORR (IF NEEDED)

QUALITY CHECKS

COLOCATION
(APPR. SPATIO-TEMP WINDOW)

GENERATE STATISTICS
FOR DIFFERENT RANGES

POST LAUNCH WITH OS-2
GRID 0.5/0.25° (2008-2009)

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SENSORS

INTER-COMPARISON - SATELLITES

PRE LAUNCH ACTIVITY WITH QS

QS LEVEL-2B DATA
0.25° (2005-2006)

WIND VECTOR FROM ASCAT,
SPEED FROM SSM/I, JASON

QUALITY CHECKS

QUALITY CHECKS

COLOCATION
(APPR. SPATIO-TEMP WINDOW)

GENERATE GLOBAL STATISTICS
FOR DIFFERENT RANGES

POST LAUNCH WITH OS-2
0.5/0.25° (2008-2009)

CALIBRATION AND VALIDATION OF IRS
SENSORS

VALIDATION - MODEL

PRE LAUNCH ACTIVITY WITH QS

QS LEVEL-2B DATA
0.25° (2005-2006)

MODEL
ANALYSIS/REANALYSIS

QUALITY CHECKS

TRANSFORM TO MODEL GRIDS

COLOCATION (APPR. SPATIO-TEMP WINDOW)

GENERATE STATISTICS
FOR DIFFERENT RANGES

POST LAUNCH WITH OS-2
GRID 0.5/0.25° (2008-2009)

CALIBRATION AND VALIDATION OF IRS
SENSORS

INDIA



As on October 31, 2007





Thank you

12:01

OCEANSAT-2 OCM chlorophyll algorithm

Bio-optical archive data collected in the Arabian Sea and from NOMAD has been used to develop OC-4 type of algorithm

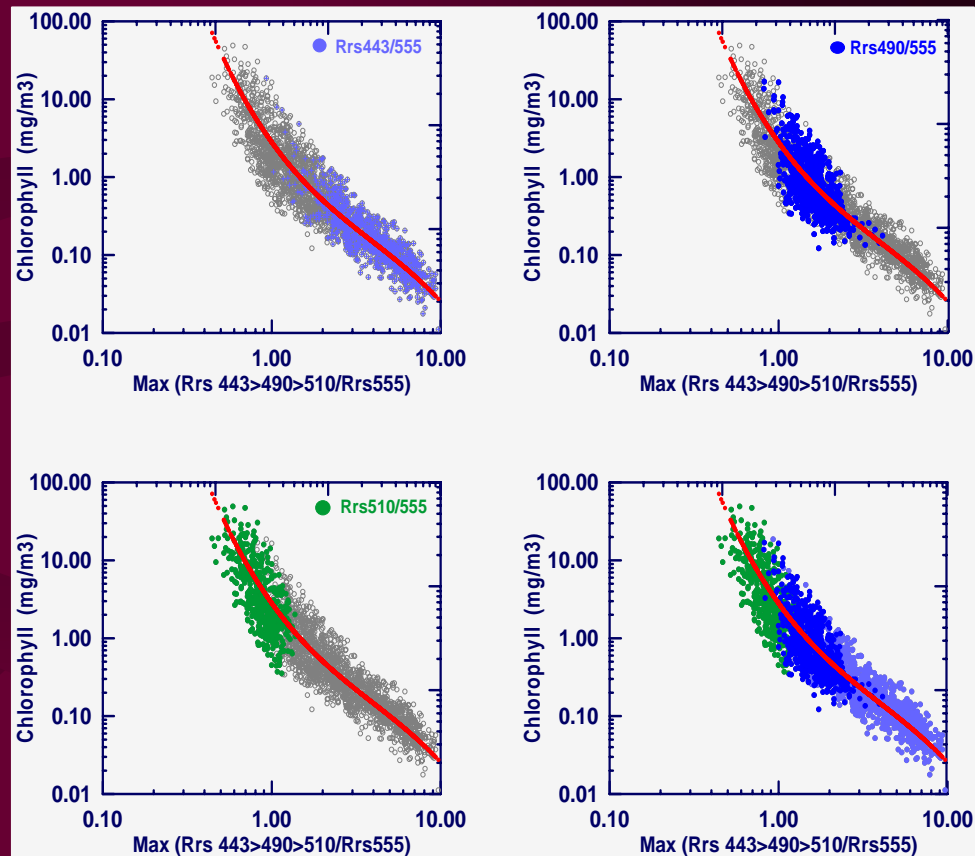
The equation has following form

$$C = 10^{(a+bR+cR^2+dR^3)} + e$$

where, C= chlorophyll;

R =
 $\log_{10}[\max(R_{rs443>490>510}/R_{rs555})]$

a = 0.48; b = -3.03; c = 2.24; d = -1.25;
 and e = -0.03



Max Ratio= Maximum ($R_{rs\ 443>R_{rs\ 490>R_{rs\ 510}/R_{rs\ 555nm}}$)

THANKS

for your kind attention...

INDIA



As on October 31, 2007



THANKS

for your kind attention...