

OCEANSAT-2

OCEAN COLOUR MONITOR (OCM-2)

Update of post launch vicarious, lunar calibrations &
current status

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OCEANSAT-2

OCEAN COLOUR MONITOR (OCM-2)

Launched : 23 Sept 2009
Orbit : 720 Km
Inclination : 98.28 deg
Revisit cycle : 2-days
Swath/Resolution : 1420 Km/
360 m X 236m
Time of Pass : 12 noon
Along track Steering : ± 20 deg

Instruments on Oceansat-2

- OCM-2: Ocean Colour Monitor
- OSCAT: Ku-band Scatterometer
- ROSA: ASI's Radio Occultation Sounder for Atmosphere



(OCM-2 Optics side)



(detector head side)

OCM-2 Design

(8 VNIR spectral bands)

- 8-element telecentric lens assembly per band
- f-length: 20 mm ; f/no. = 4.3
- FOV: ± 43 deg
- 2-element bandpass filter + 1 thermal filter
- 3730 of 6k element linear array CCD device
- 12 – bit quantisation
- Exposure (gains) : 16 levels
- SNR > 512 at saturation (land reflectance)
- Band-to-band registration : ± 0.25 pixel
- MTF > 0.26
- 4 LED's as onboard cal source per band

PRE-LAUNCH PERFORMANCE (Radiometric/Spatial)

Uncertainty in radiometric calibration:

- Veiling Glare of Lens Assembly : < 1.6 %
- Polarization of lens assembly: < 2.3 %
- Absolute calibration of standard source @ 655 nm < 2.4 %
- Transfer radiometer uncertainty < 2.0 %
- Non uniformity of integrating sphere < 4.0 %

Overall Absolute Radiometric Uncertainty(1 σ) < 6 %

Instrument Spectral Bands	Wavelength Range (nm)	SNR @ Ref Radiance	Nominal reference radiance of Sea (mW/cm ² /sr/ μ m)	Saturation radiance (mW/cm ² /sr/ μ m)
C1	402-422	356	9.1	70.2
C2	433-453	386	8.4	36.5
C3	480-500	380	6.6	29.6
C4	500-520	324	5.6	25.8
C5	545-565	311	4.6	21.2
C6	610-630	240	2.5	16.0
C7	725-755	286	1.6	1.9
C8	845-885	141	1.1	14.3

MTF Performance @ nadir (360m X 360 m)

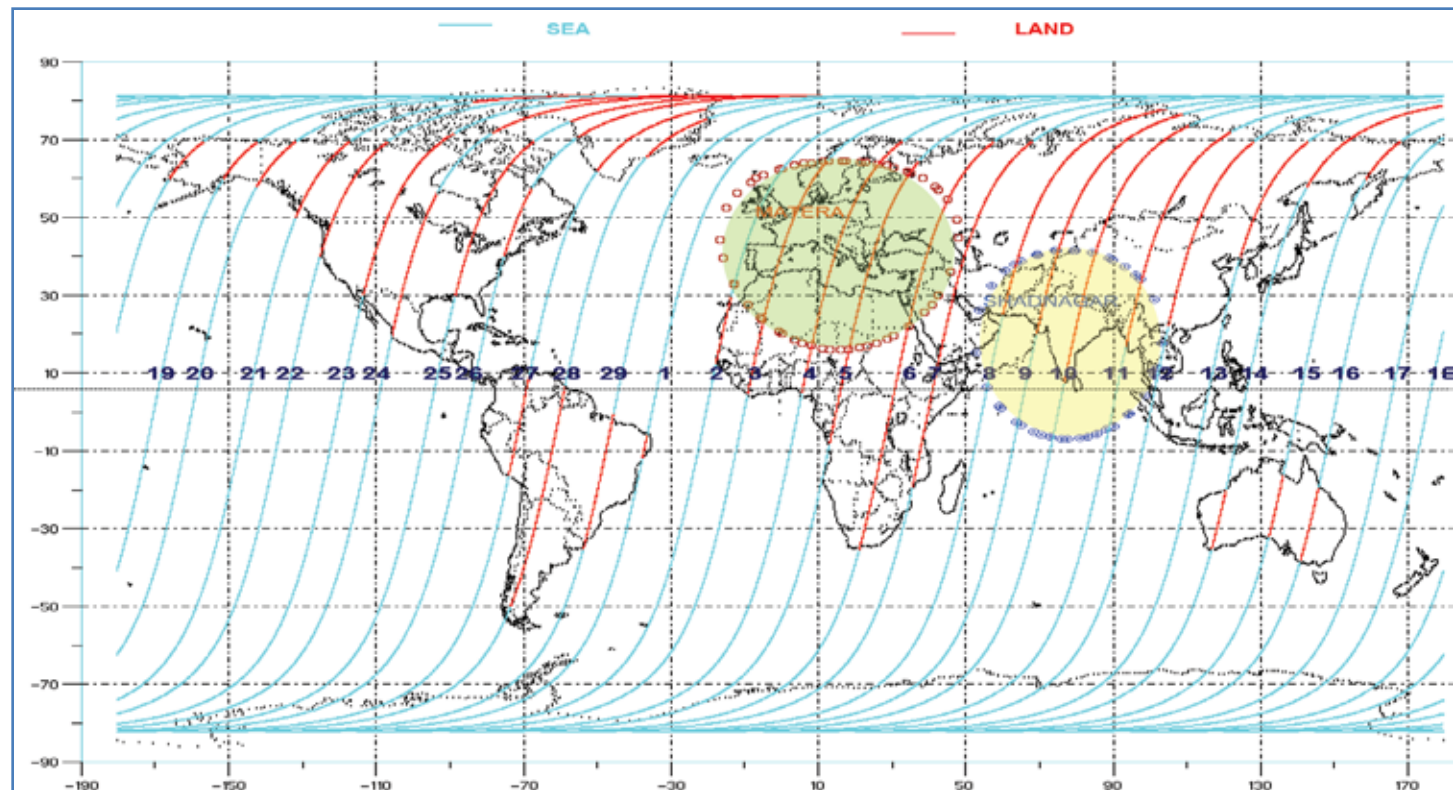
- Lens MTF 0.55
- Device MTF
 - Along Track 0.75
 - Across track 0.57
- Due to alignment & Envir. 0.84
- System MTF
 - Along Track 0.34
 - Across Track 0.26

Mis-registration (Band-to-Band) in pixel

- BBR @ Ambient ± 0.16
- Format matching (+test set up) ± 0.15
- Distortion ± 0.05
- BBR Stability (environment) rss ± 0.16
- Collinearity ± 0.10
- Format Change ± 0.10
- Structural stability ± 0.05
- Distortion change due to environment ± 0.05

Overall mis-registration (band-to-band) ± 0.23

MODES OF OPERATIONS



Local Area Coverage (LAC) with 360m, real time transmission

Global area coverage (GAC) with 1 km, on-board Recording & playback

GAC data coverage between $\pm 75^\circ$ Latitude covering full globe in 8 days

OCEANSAT-2 OCM Data products

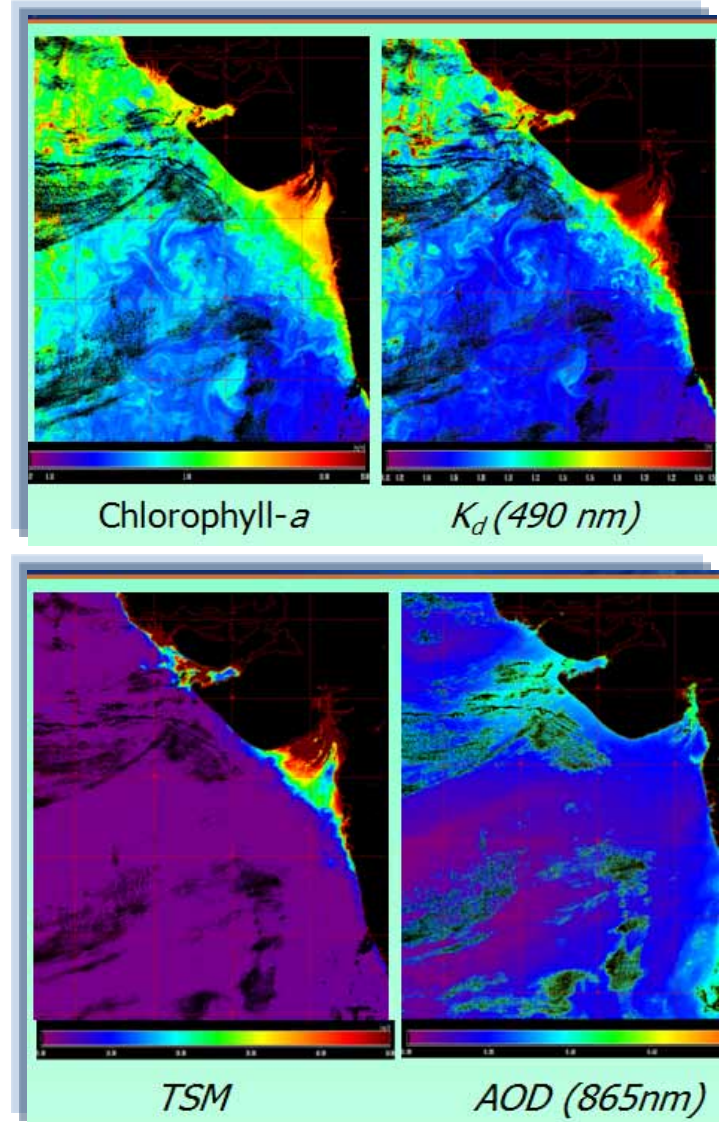
LEVEL-1 Product: Basic Data Products

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

LEVEL-2 Product: Geo-Physical Parameters

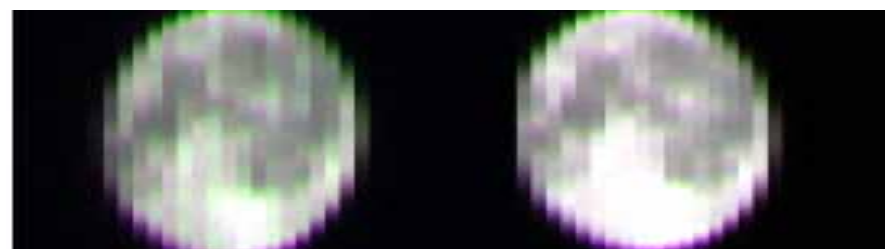
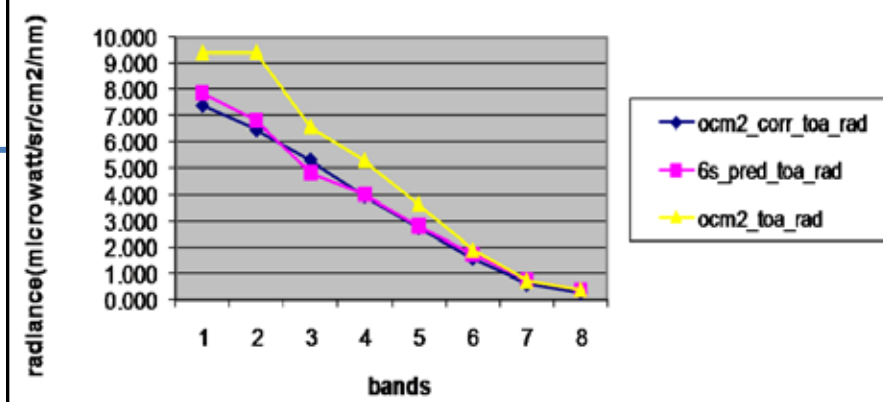
- Chlorophyll-*a* concentration
- Total Suspended Matter (TSM)
- Diffused Attenuation Coefficients (K_d - 490 nm)
- Aerosol Optical Depth (AOD) at 865 nm

Products supported in HDF 4 format can be Displayed and processed in SeaDas



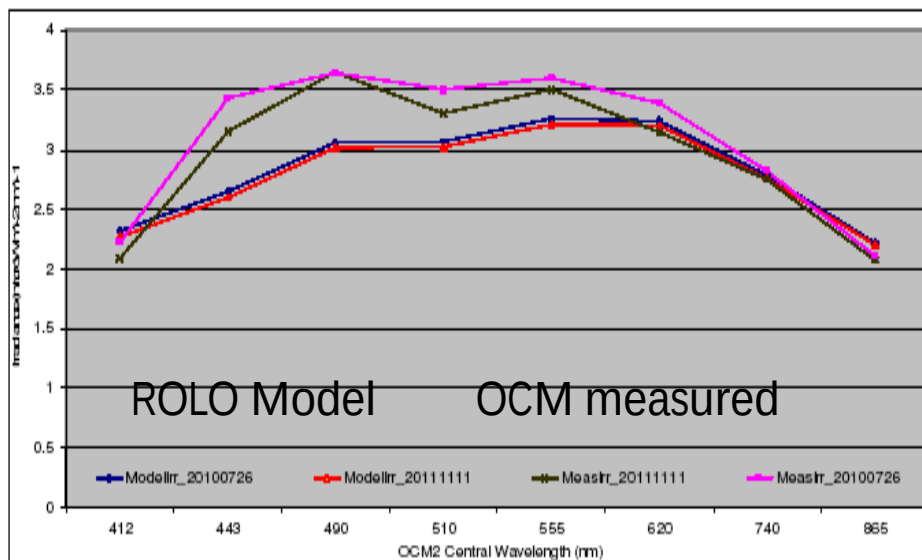
Absolute Radiometric Cal & Lunar Calibration of OCM -2

Three Moon acquisitions for OCM-2 were done 26-7-2010, 11-11-2011 and 1 Aug 2012

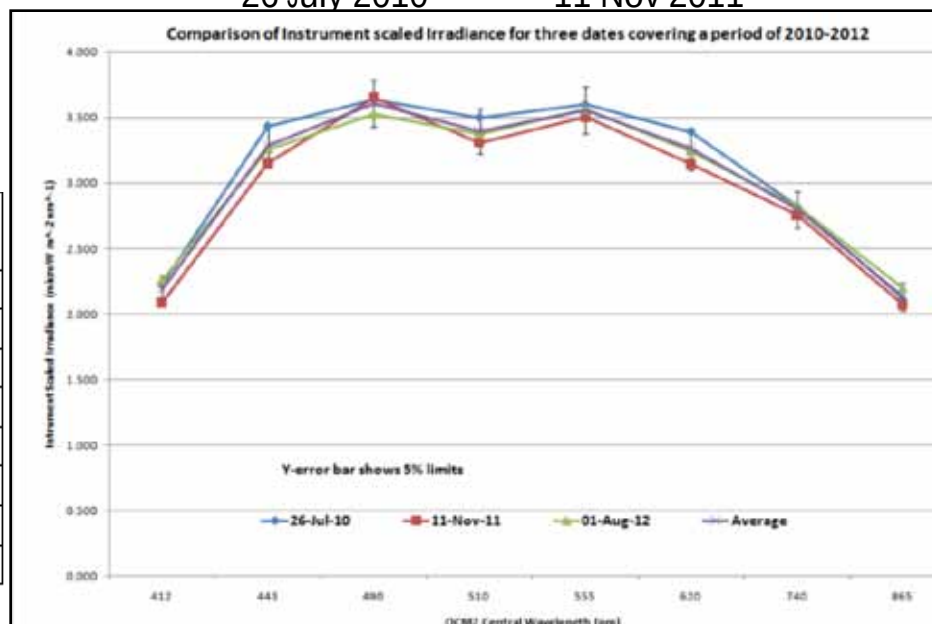


26 July 2010

11 Nov 2011



CW (nm)	260710	111111	% variation of 111111 wrt 260710
412	1.041152	1.087995	4.499151
443	0.770421	0.824635	7.036932
490	0.841481	0.825392	-1.91199
510	0.876796	0.914517	4.302141
555	0.904445	0.917074	1.396326
620	0.955636	1.018487	6.576877
740	0.986744	1.003452	1.693246
865	1.050061	1.063507	1.280497



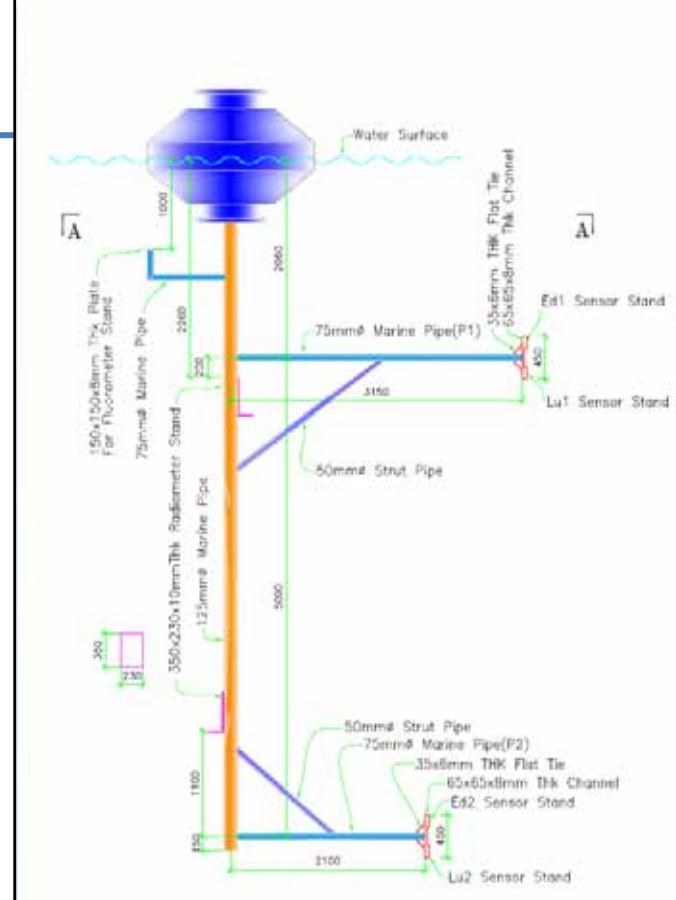
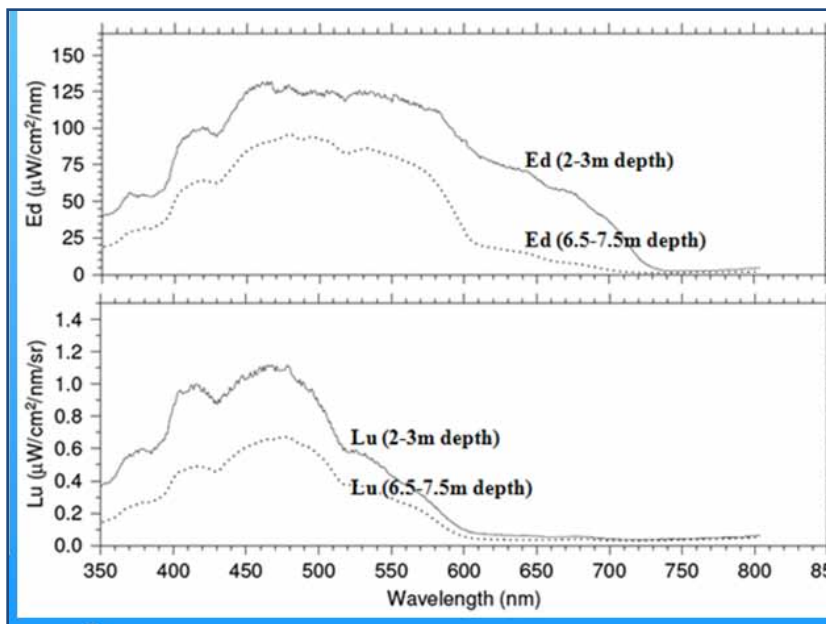
Vicarious Calibration of OCM -2

Vicarious calibration is considered as a tool for

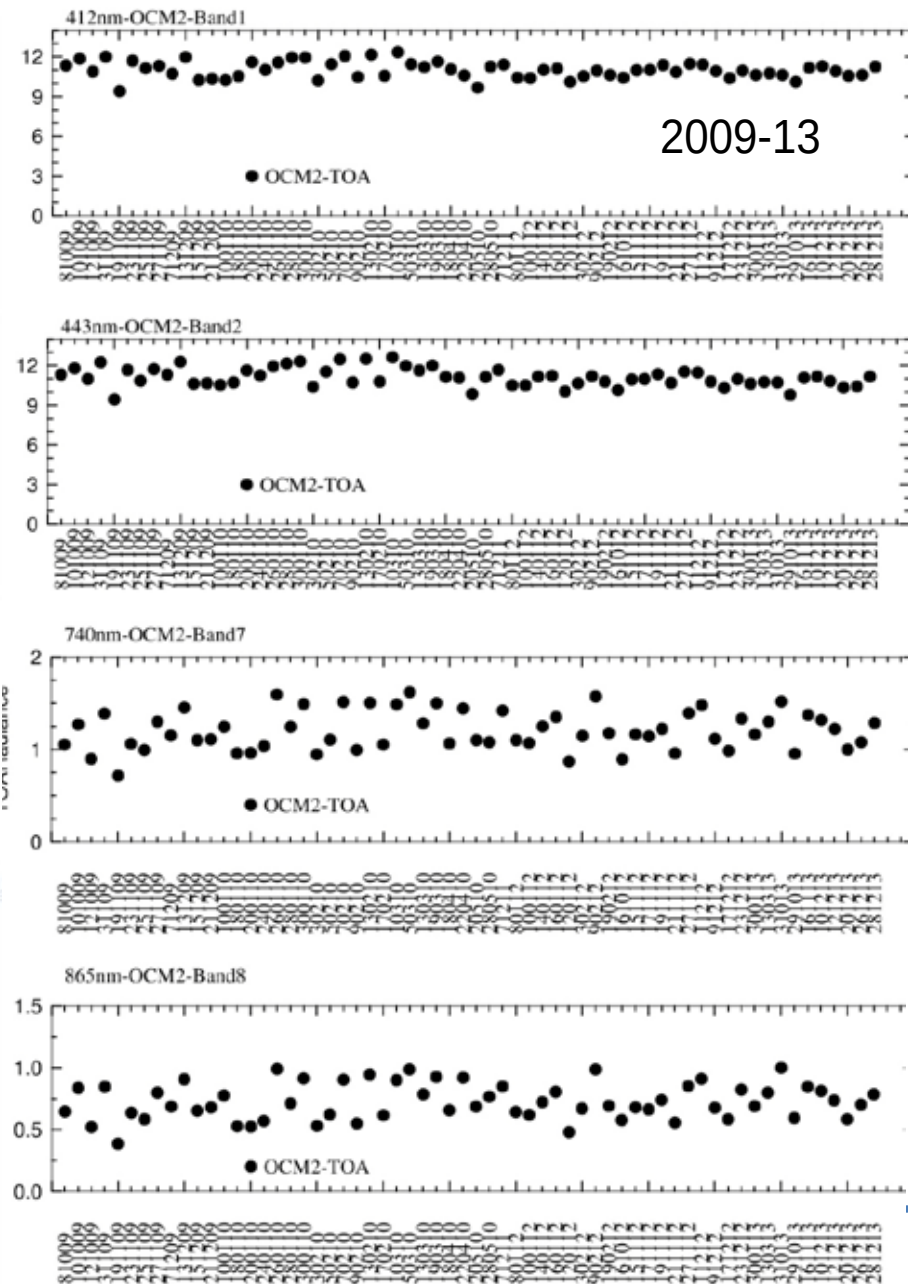
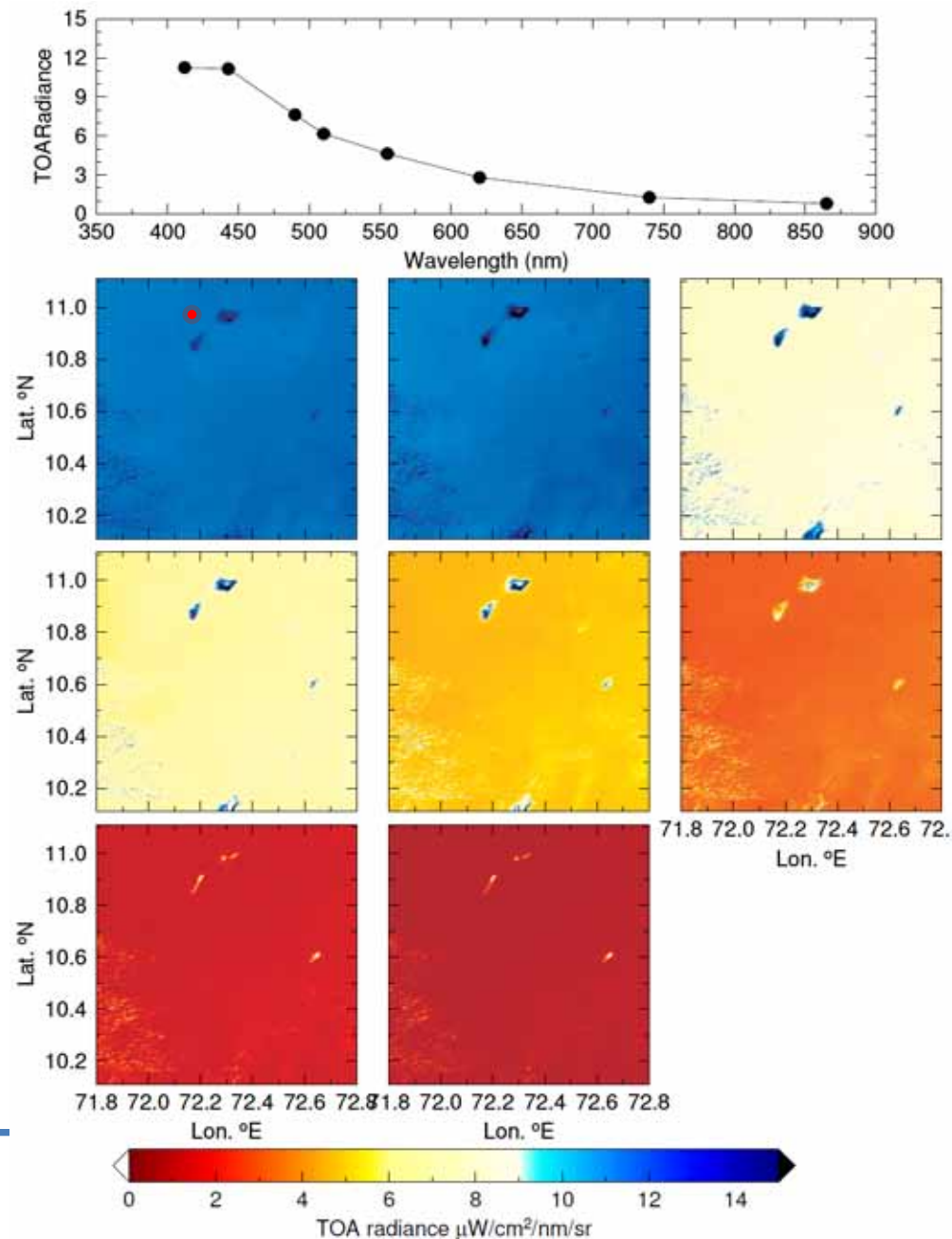
- verifying the pre-launch calibration data
- evaluating possible sensor decay with ageing

Cal/Val site at Kavaratti in Arabian sea

- *In water sea reflectance* data is being collected in low chlorophyll waters ($<0.125 \text{ mg/m}^3$);
- Under clear atmospheric conditions ($\text{AOD}_{870\text{nm}} < 0.2$); using hyper spectral instruments; and well calibrated field instruments

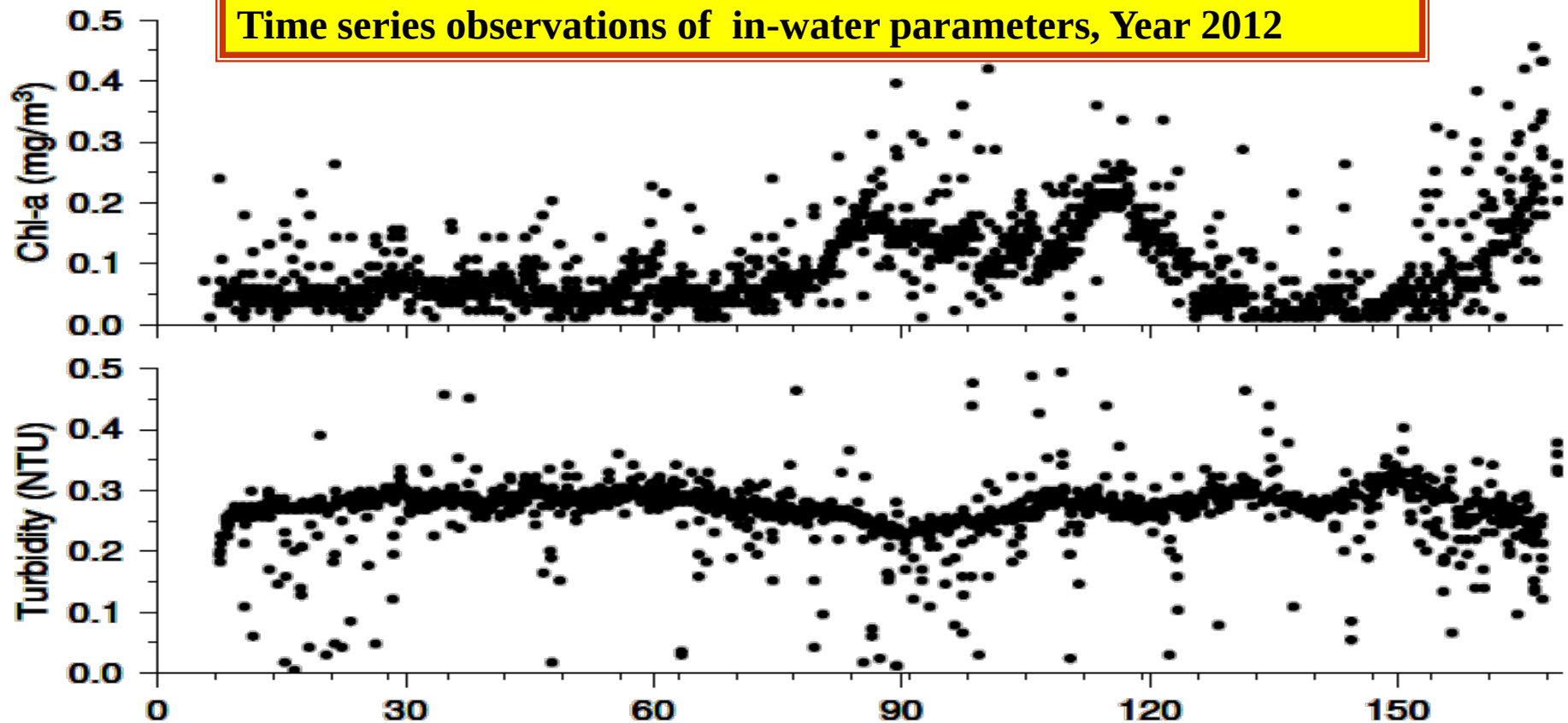


Long Term ocean reflectance observations using Kavaratii buoy

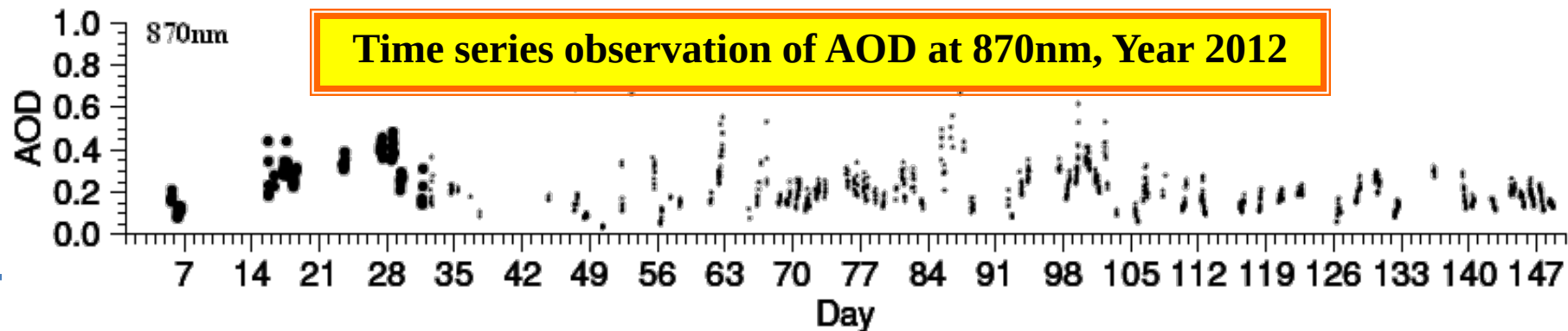


Ocean & Atmospheric Parameter variability at KVT

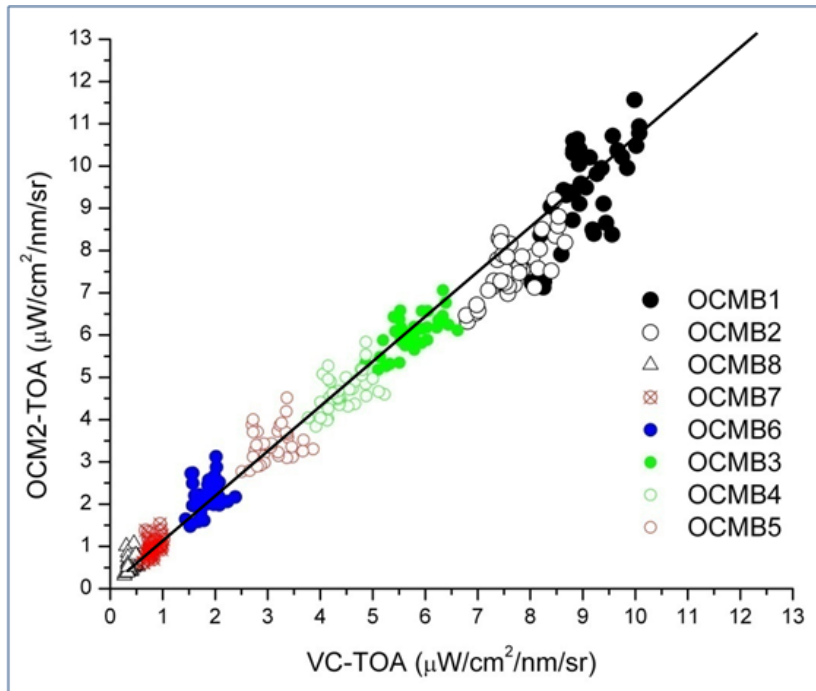
Time series observations of in-water parameters, Year 2012



Time series observation of AOD at 870nm, Year 2012



Vicarious Calibration Results (2009-2013)



Band No.	Total points	% error	CC (R^2)	Mean TOA radiance ($\mu\text{W}/\text{cm}^2/\text{sr}/\text{nm}$)	
				KVT	OCM-2
1	27	4.24	0.88	9.06	9.47
2	31	4.65	0.86	7.65	7.52
3	33	3.50	0.73	5.76	5.98
4	30	4.92	0.76	4.43	4.54
5	20	10.51	0.74	3.11	3.20
6	21	14.32	0.61	1.92	2.09
7	30	6.76	0.60	0.81	0.92
8	26	12.92	0.69	0.39	0.50

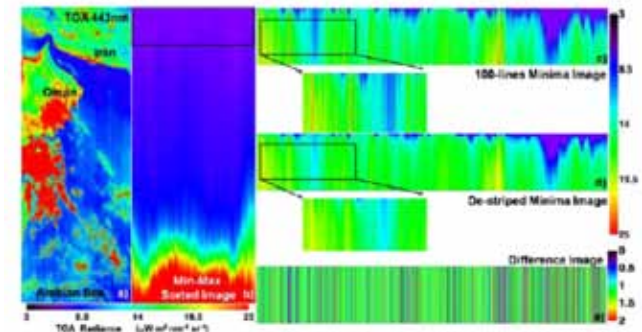
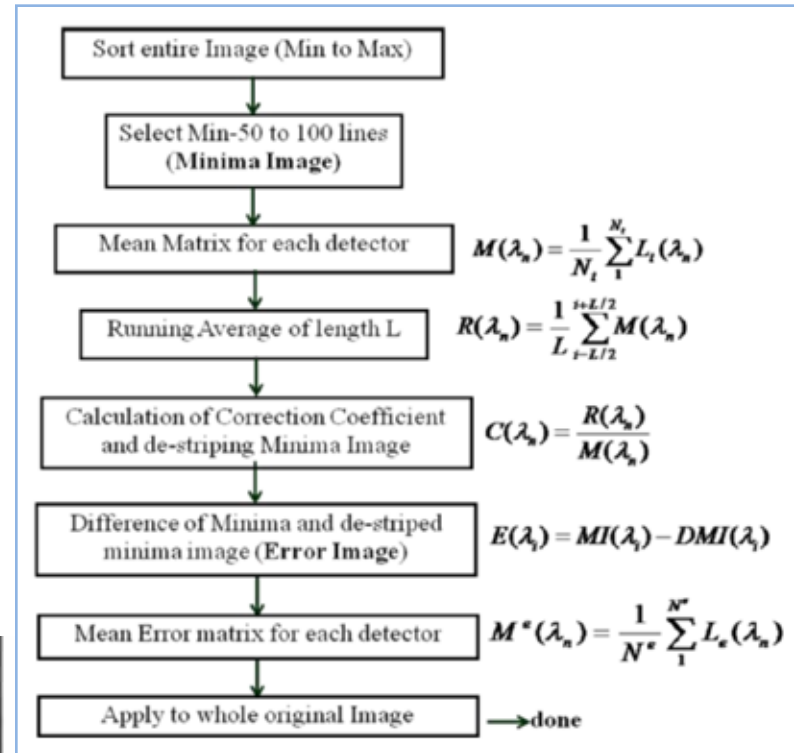
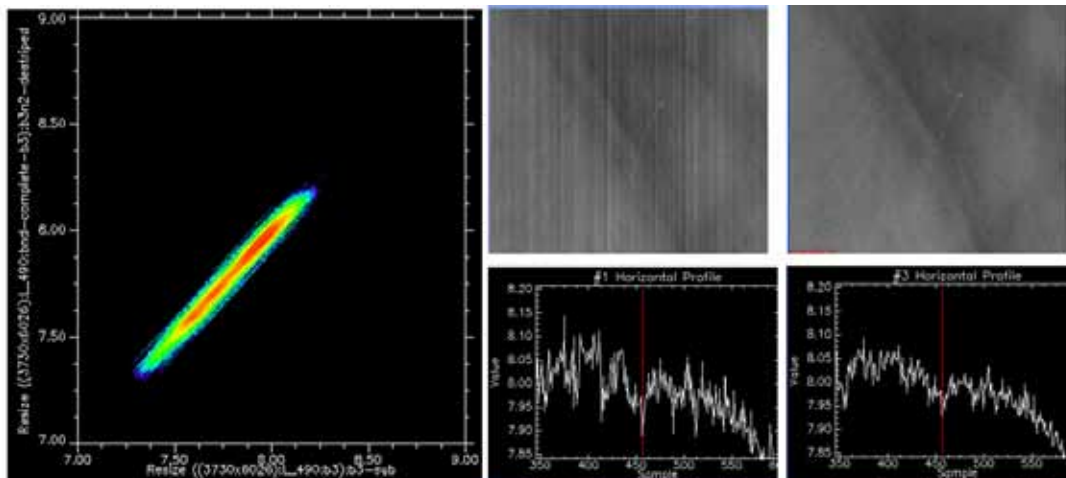
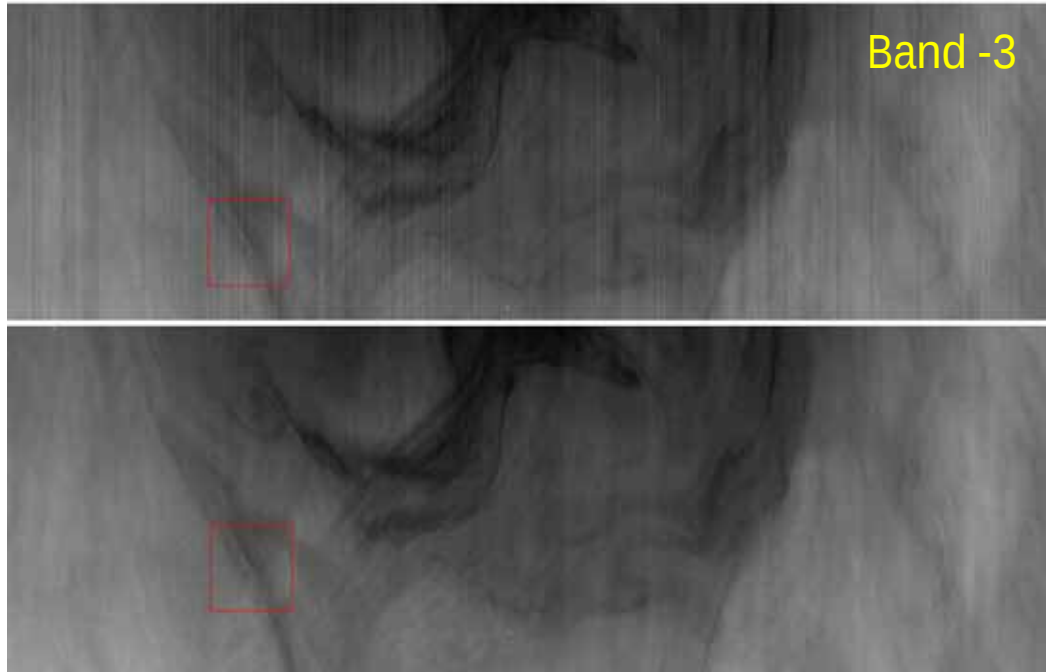
Band	Year 2009-10	Year 2011	Year 2012
	Gain $\pm$ SD	Gain $\pm$ SD	Gain $\pm$ SD
1	0.93 $\pm$ 0.04	0.97 $\pm$ 0.03	0.95 $\pm$ 0.03
2	1.03 $\pm$ 0.04	1.06 $\pm$ 0.04	1.06 $\pm$ 0.02
3	0.96 $\pm$ 0.04	0.97 $\pm$ 0.04	0.92 $\pm$ 0.04
4	1.00 $\pm$ 0.07	0.97 $\pm$ 0.05	0.97 $\pm$ 0.04
5	1.00 $\pm$ 0.09	0.93 $\pm$ 0.07	0.91 $\pm$ 0.05
6	0.95 $\pm$ 0.08	0.86 $\pm$ 0.07	0.87 $\pm$ 0.06
7	0.88 $\pm$ 0.07	0.88 $\pm$ 0.06	0.92 $\pm$ 0.07
8	0.88 $\pm$ 0.05	0.71 $\pm$ 0.05	0.81 $\pm$ 0.02

Gain coefficients (2013)

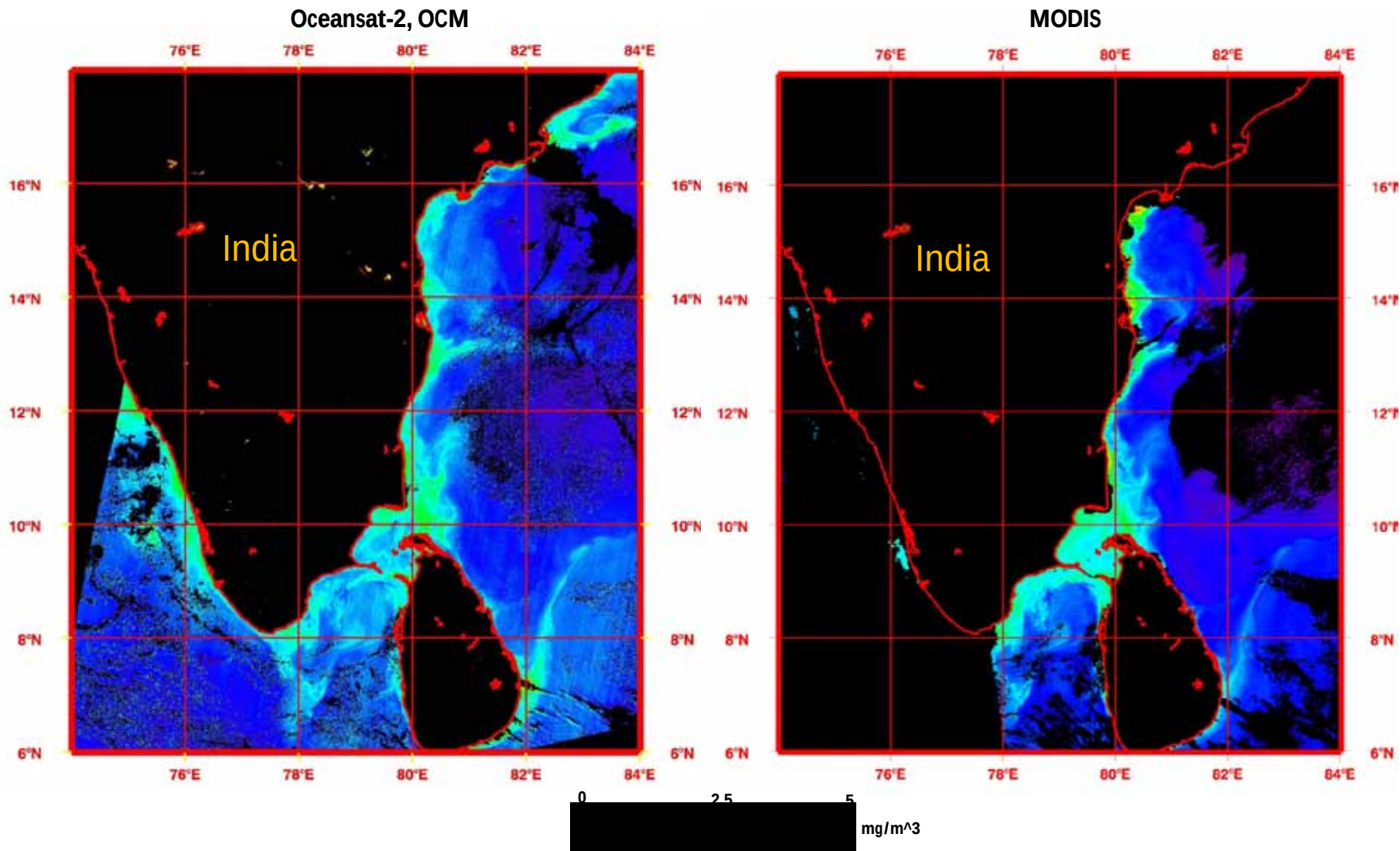
B1- 0.95 B2- 1.02 B3- 0.96 B4- 0.98
B5-0.97 B6- 0.93 B7 -0.88 B8-0.80

Relative radiometric calibration of OCM2 data

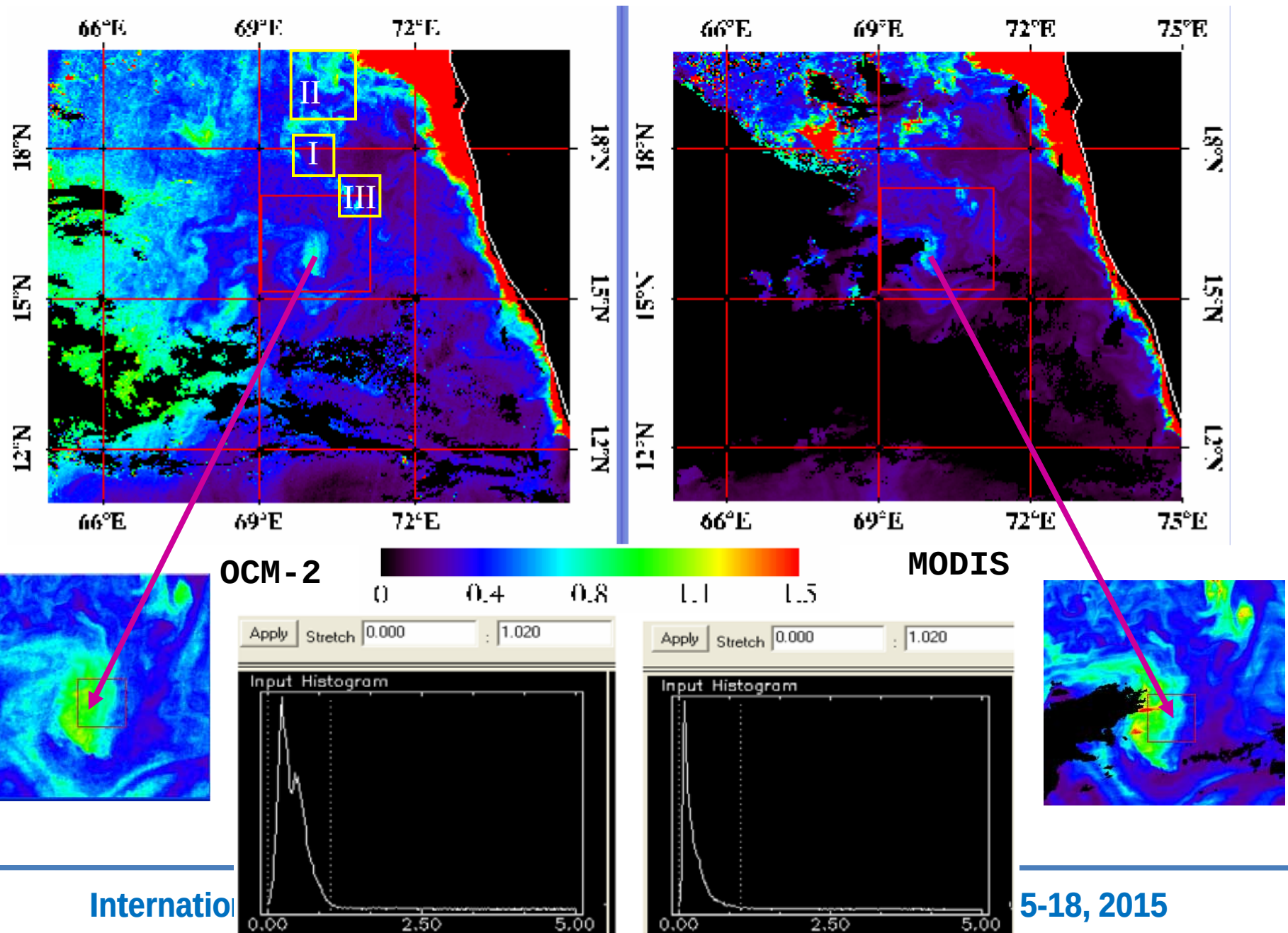
Algorithm details



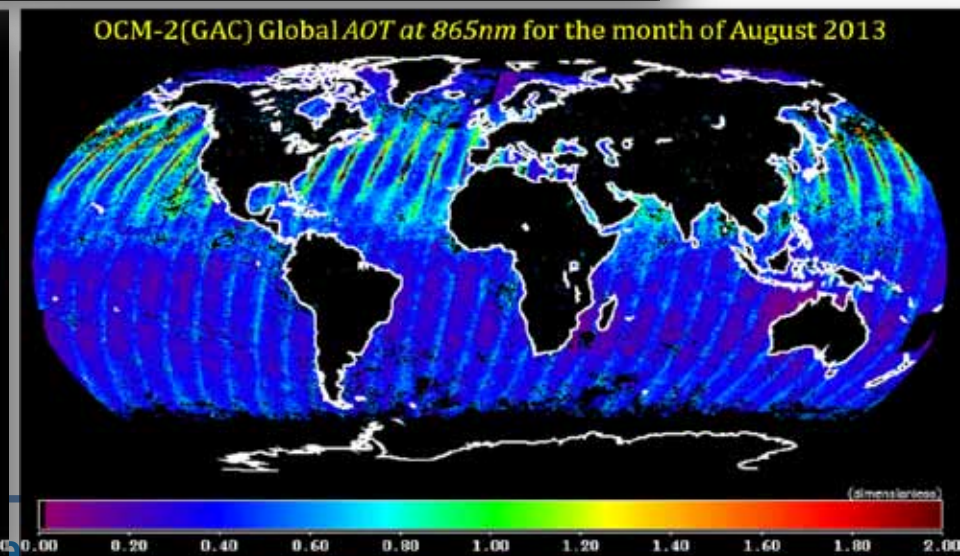
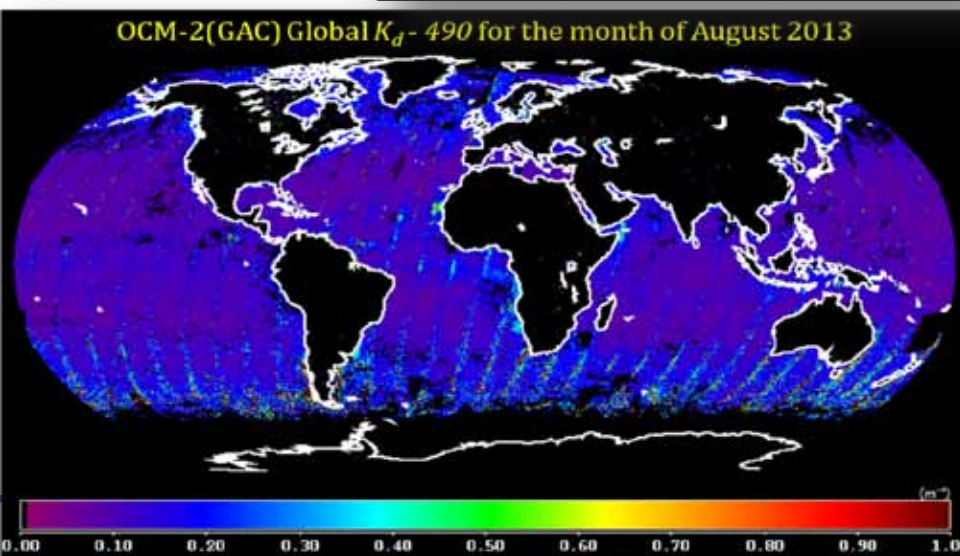
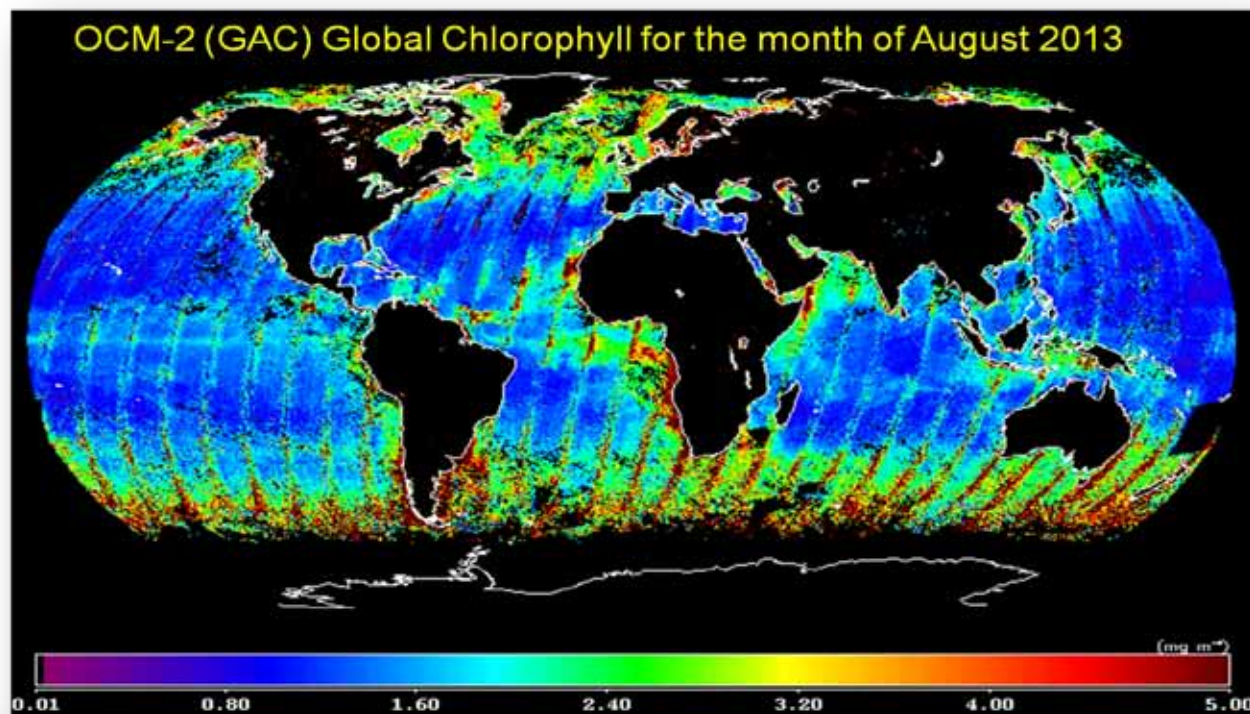
Retrieved Chl-a from OCM-2 and MODIS, 25th September-2011 (After moon calibration of OCM-2)



MODIS & OCM comparison

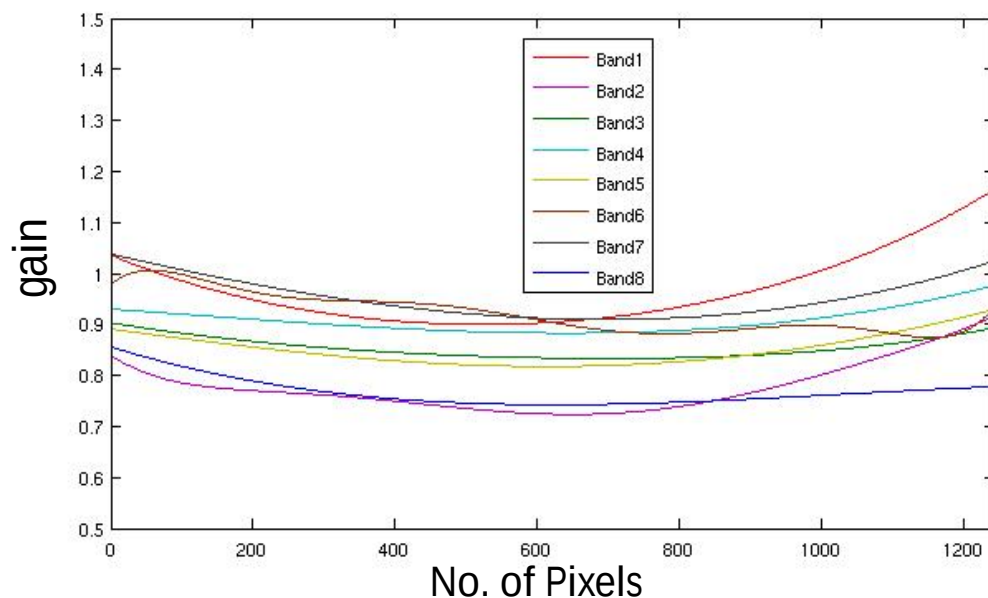


Global Monthly products from OCM-2

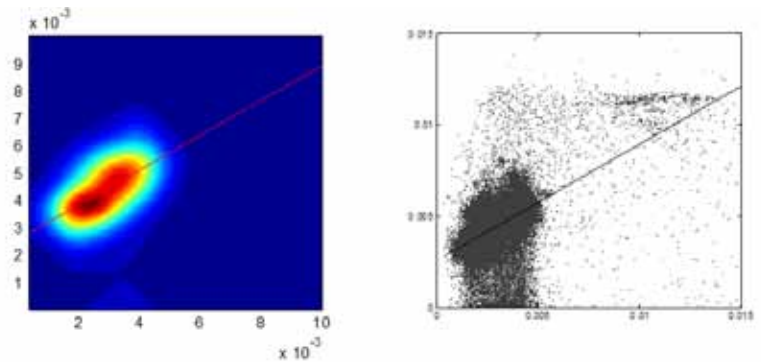
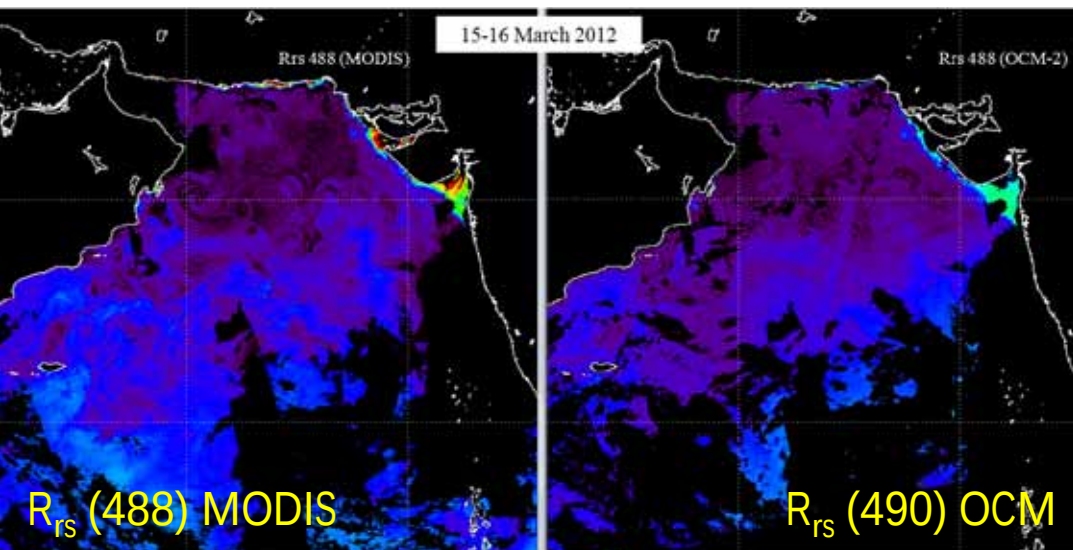


Rayleigh Calibration

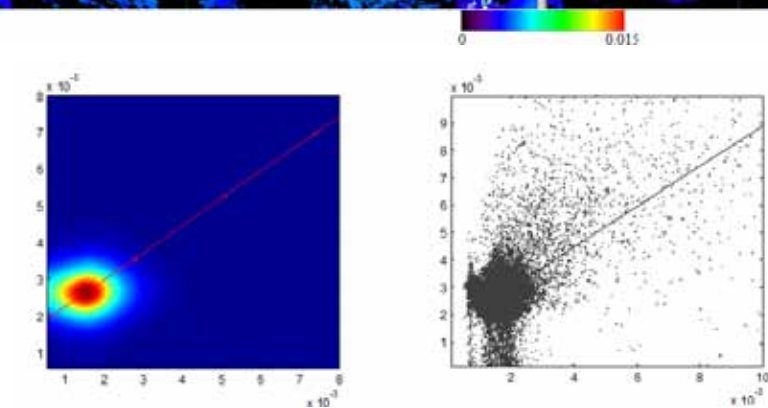
- Observe the atmosphere over ocean (dark)
- Rayleigh scattering : > 80% of signal
- TOA reflectance well predicted using RT models
- Data Source s
 - ocean surface reflectance :
 - predicted using climatology derived from SeaWiFS
 - only over very stable oceanic zones (oligotrophic zones)
 - aerosols : estimated using MODIS 865 nm band
 - Only optical thickness < 0.1 are kept



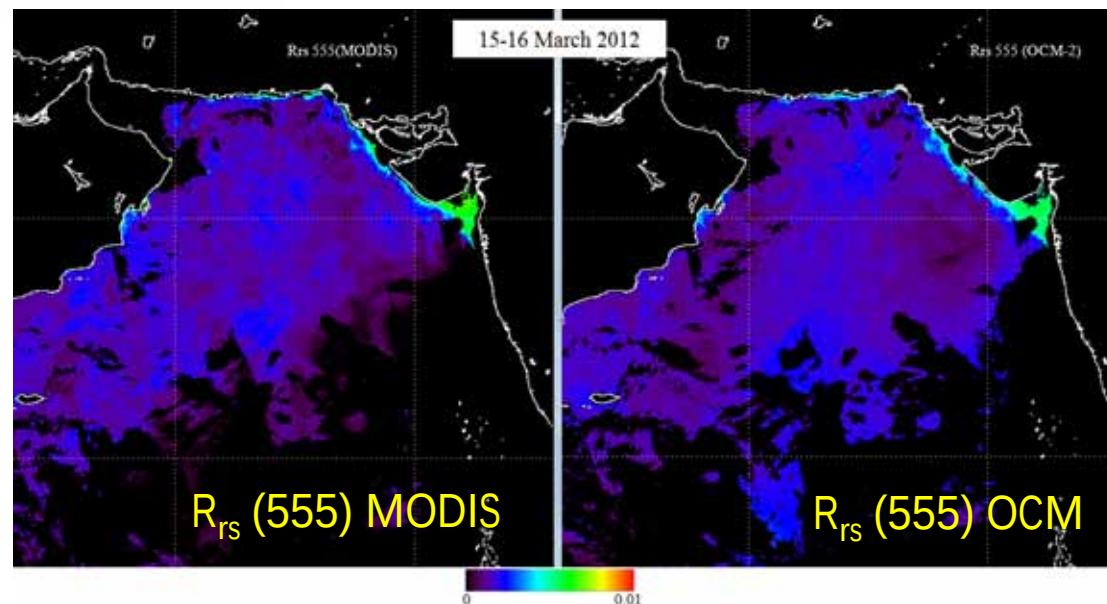
Rayleigh Calibration (Results)



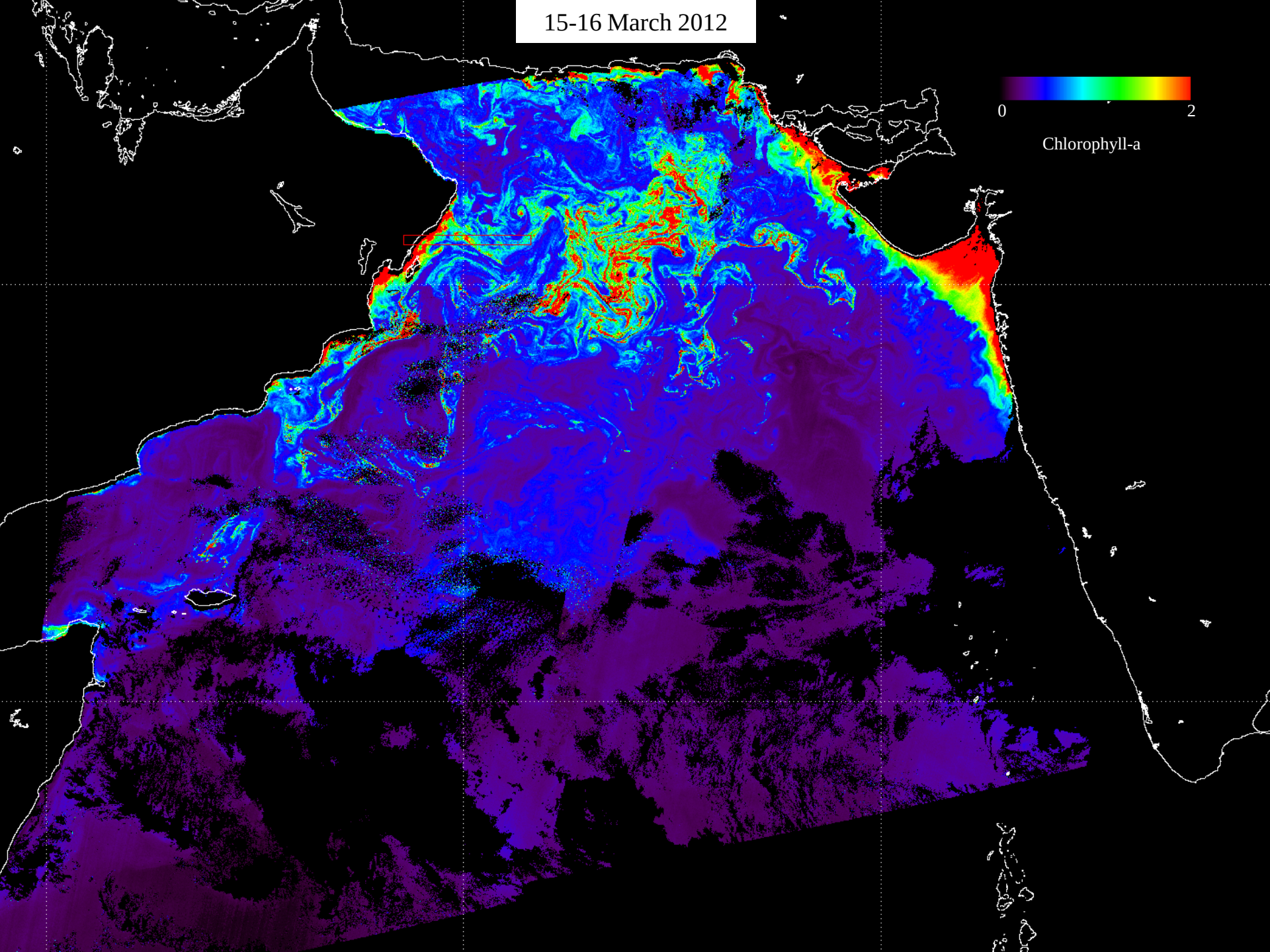
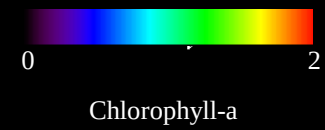
Y=Rrs(490) OCM
X=Rrs(490) MODIS
Y=0.65X+0.002573
R=0.65
RMSE=0.001



Y=Rrs(555) OCM
X=Rrs(555) MODIS
Y=0.74X+0.0015
R=0.85
RMSE=0.0007

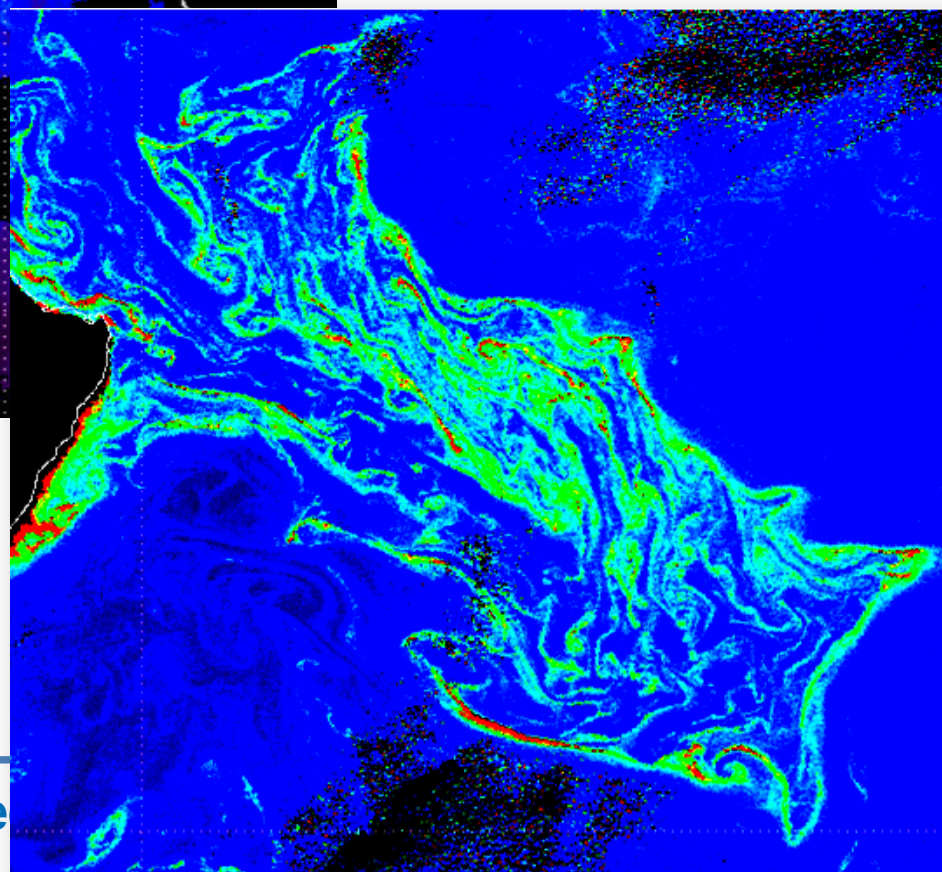
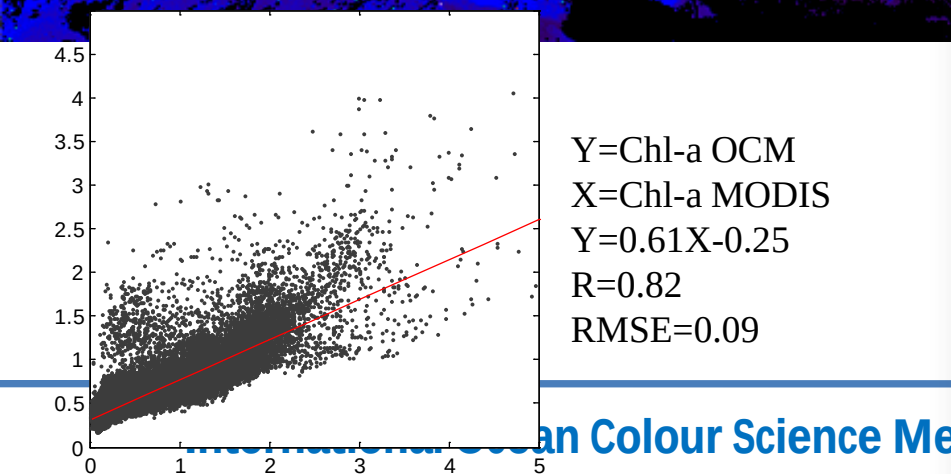
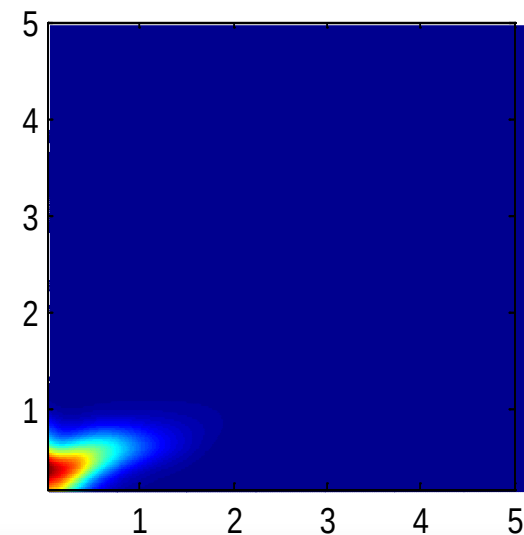
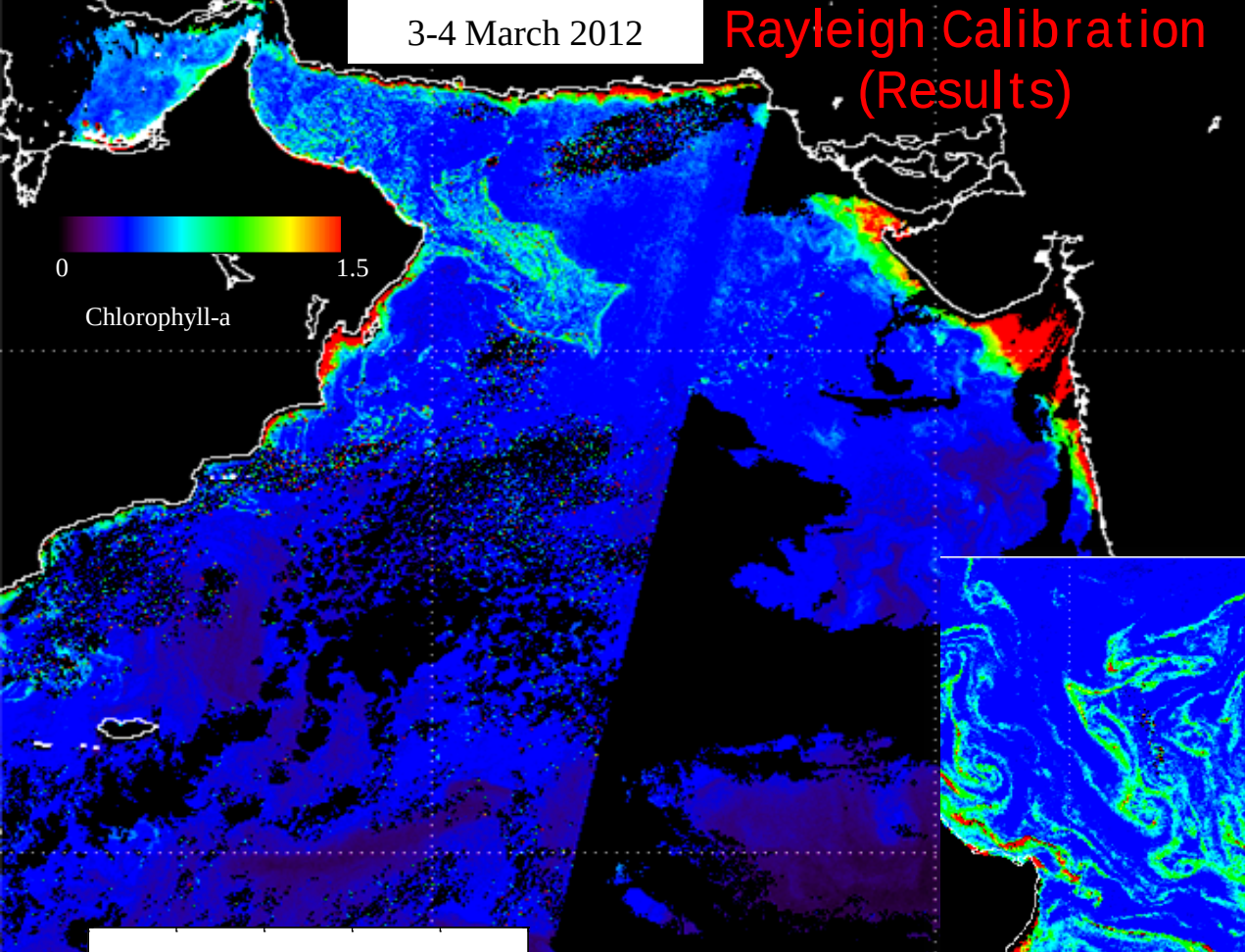


15-16 March 2012

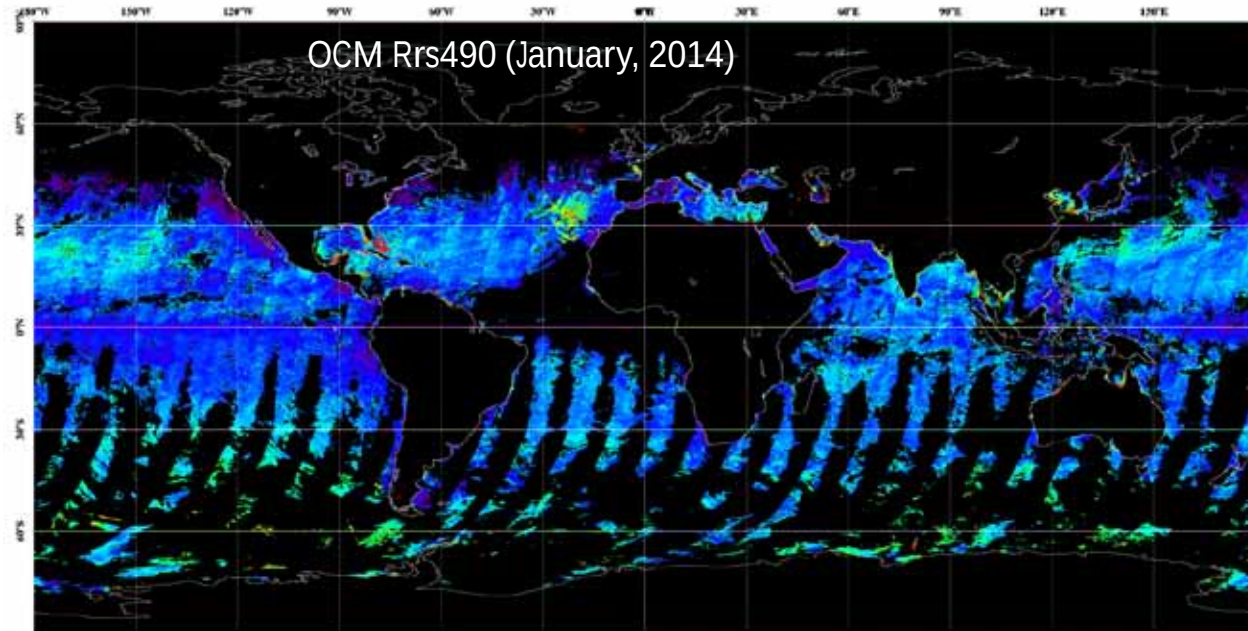


3-4 March 2012

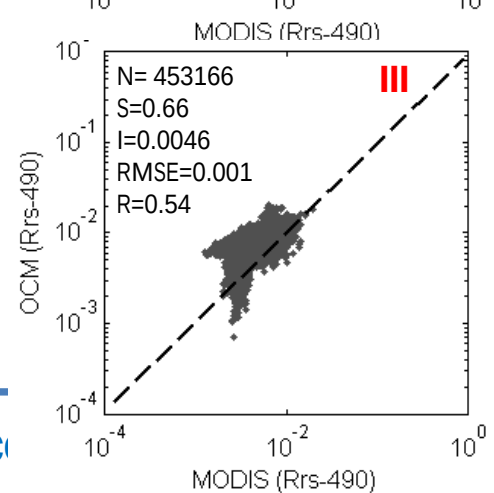
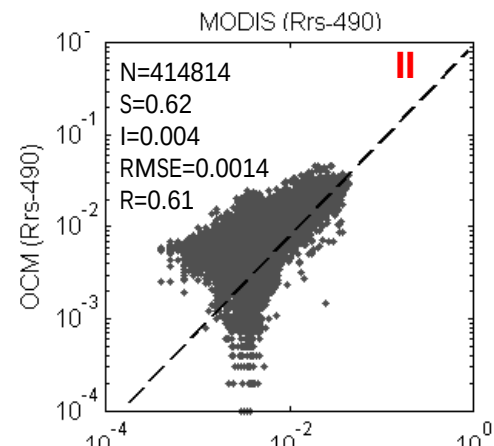
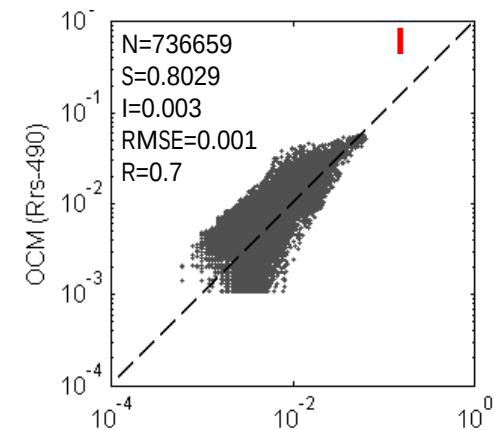
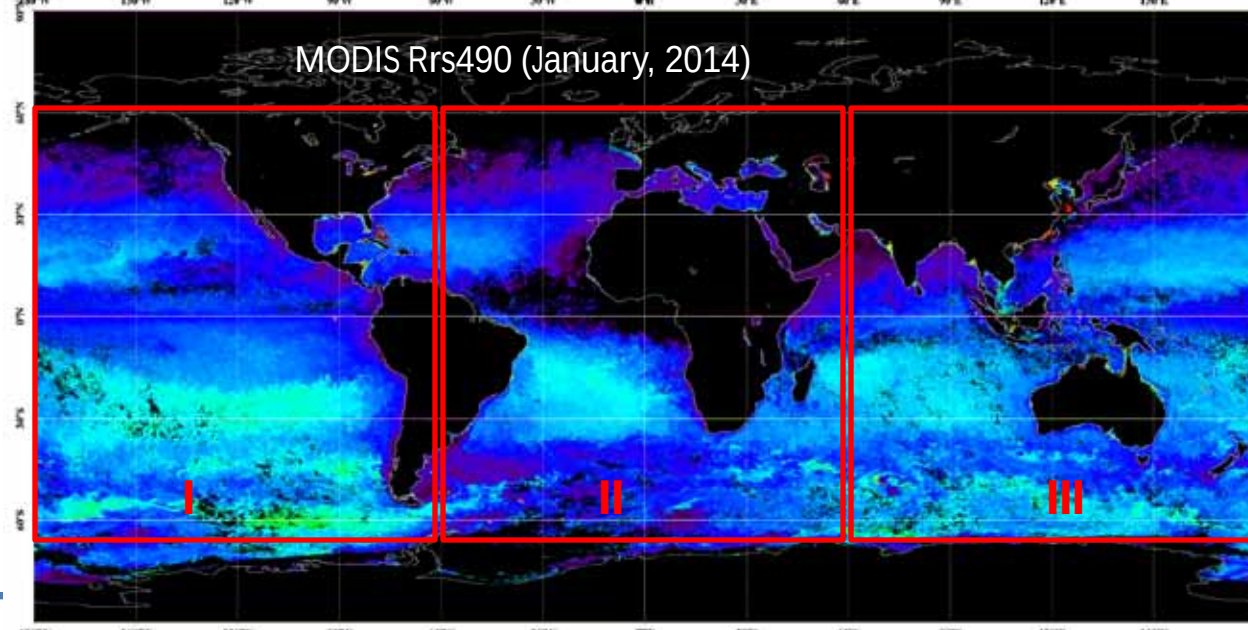
Rayleigh Calibration (Results)



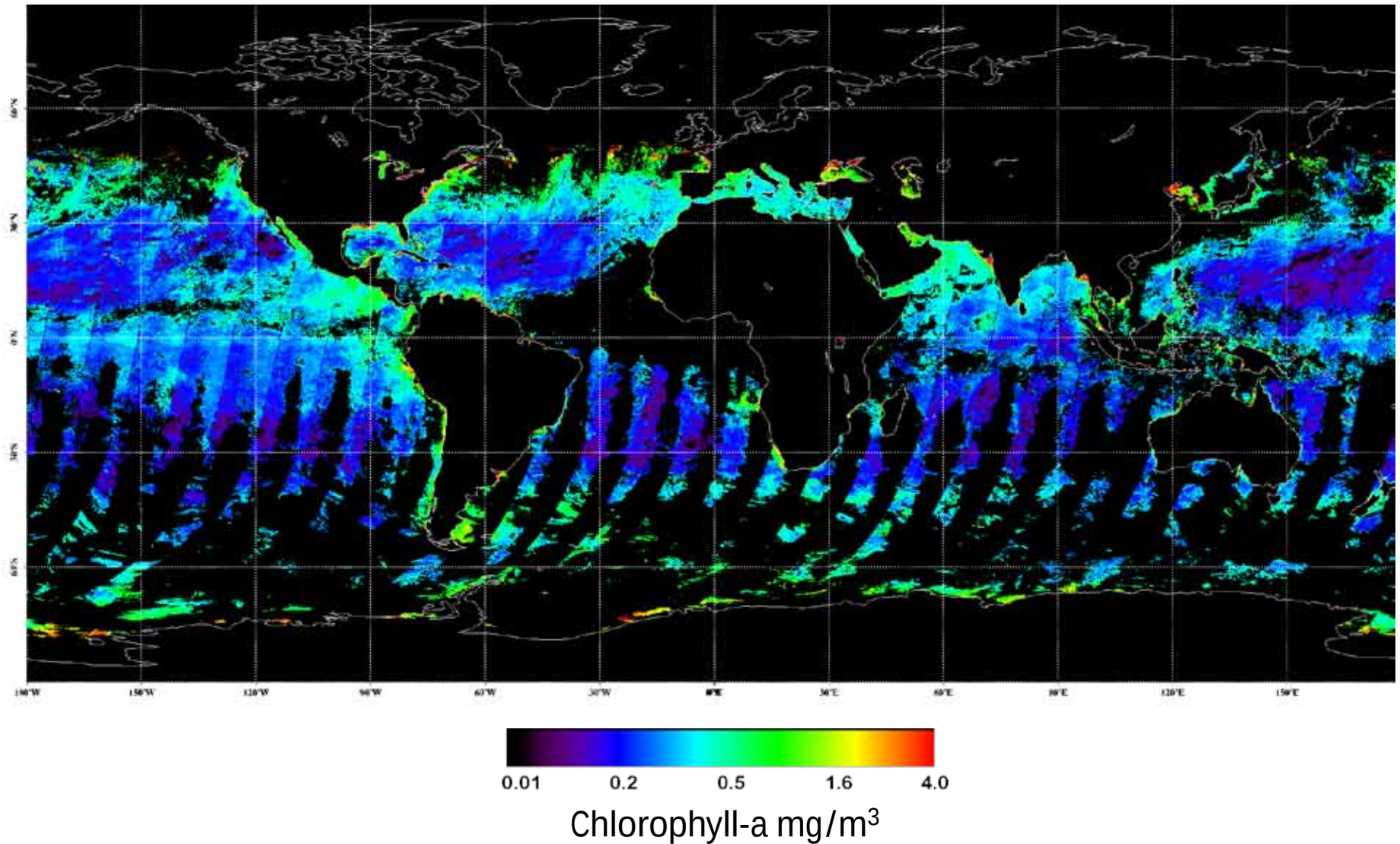
OCM Rrs490 (January, 2014)



MODIS Rrs490 (January, 2014)



Reprocessed Global Chlorophyll-a distribution (January, 2012)



Summary

- Post launch Lunar and Vicarious calibration techniques have been used to assess the radiometric cal of OCM-2 data
- Lunar calibration using ROLO model has improved the geophysical retrieval.
- Vicarious Calibration has helped in tracing the radiometric stability
- Relative radiometric calibration techniques have reduced striping
- Rayleigh calibration has helped further in overall improvement of global geophysical products

*KVT Cal/Val buoy data available from
www.mosdac.gov.in*

Thank You

