Report on ISRO Cal/Val activities

Santhi Sree Basavaraju,

& K. N. Babu ISRO

Agenda Item #1.13

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8th - 10th July 2025

CEOS

Committee on
Earth Observation Satellites

Outline of the presentation

1. **Radiometric calibration status (Optical / Thermal / Microwave)**

   - Resourcesat-2A (Three-tier imaging natural resource monitoring)
   - EOS-6 (Ocean Color Monitor sensor)
   - INSAT-3DS (Geostationary meteorological mission)
   - EOS-4(C-Band Full polarimetric SAR Mission)
   - EOS-6 (Scatterometer)

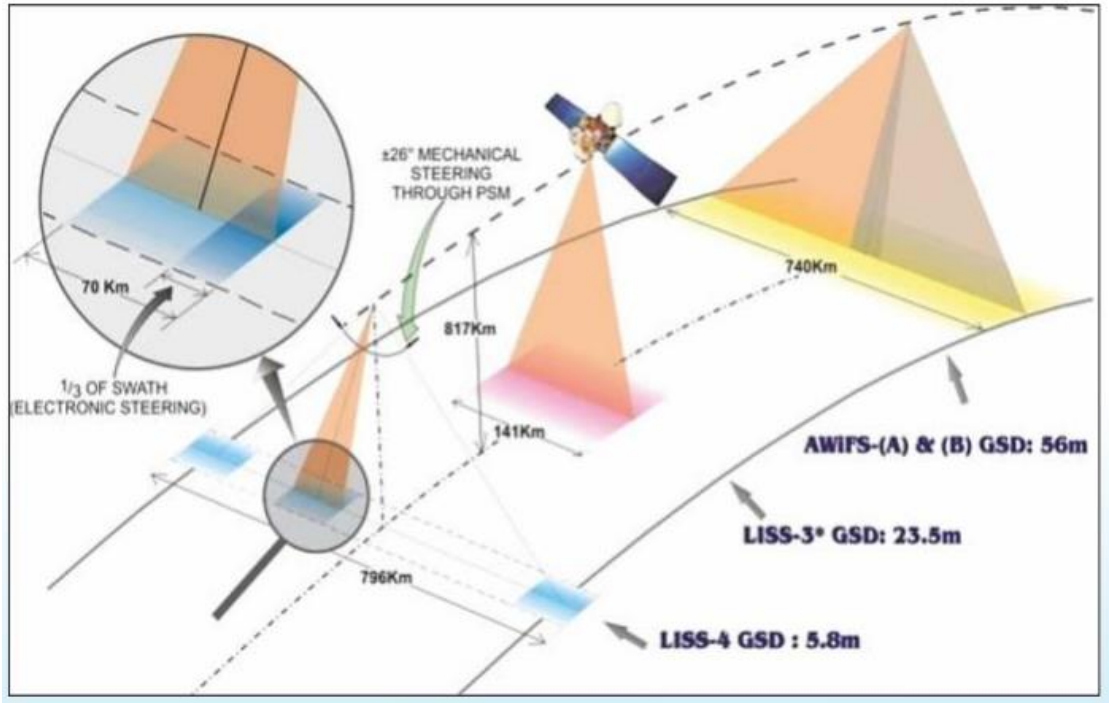
2. **Readiness for new missions / Projects**

   - NISAR
   - TRISHNA
   - P-band SAR
   - NADIR portal

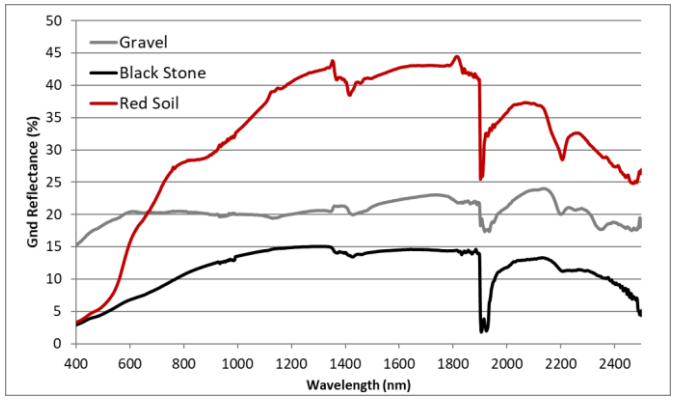
Resourcesat-2A status

- Continuation mission to Resourcesat-2.
- Launched in December 2016
- Operational Period: 8+ years (planned 5 years)

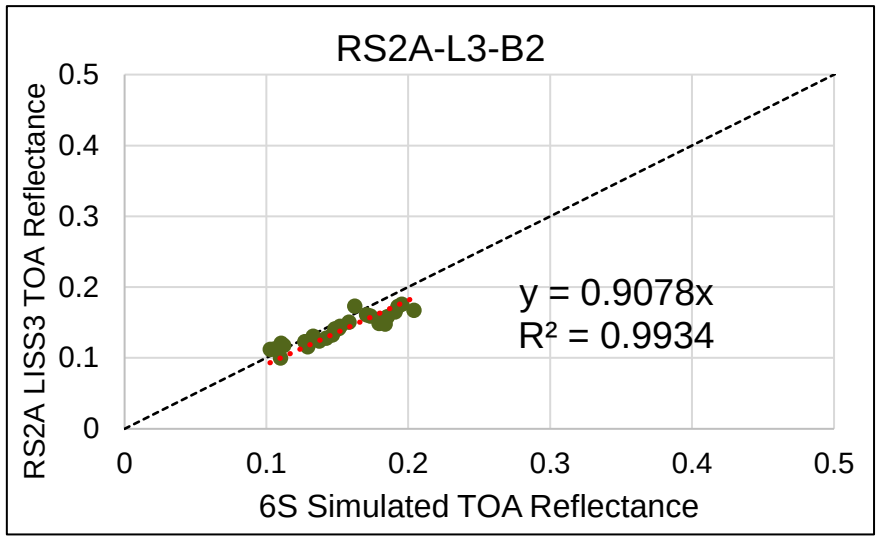
Payload	LISS-4	LISS-3	AWiFS
Spatial Resolution (m)	5.8	23.5	56
Swath (km)	70.0 in MX mode and Mono mode	141	740
Spectral Band (microns)	0.52-0.59 0.62-0.68 0.77-0.86	0.52-0.59 0.62-0.68 0.77-0.86 1.55-1.70	0.52-0.59 0.62-0.68 0.77-0.86 1.55-1.70
Quantisation (bits)	10	10	12 (VNIR) 14 (SWIR)
Data Rate (MBPS)	105	105	105

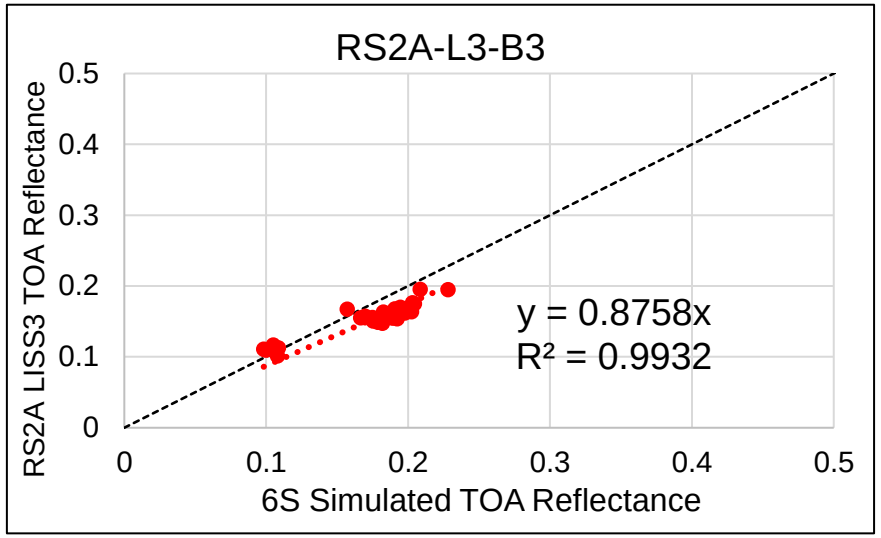


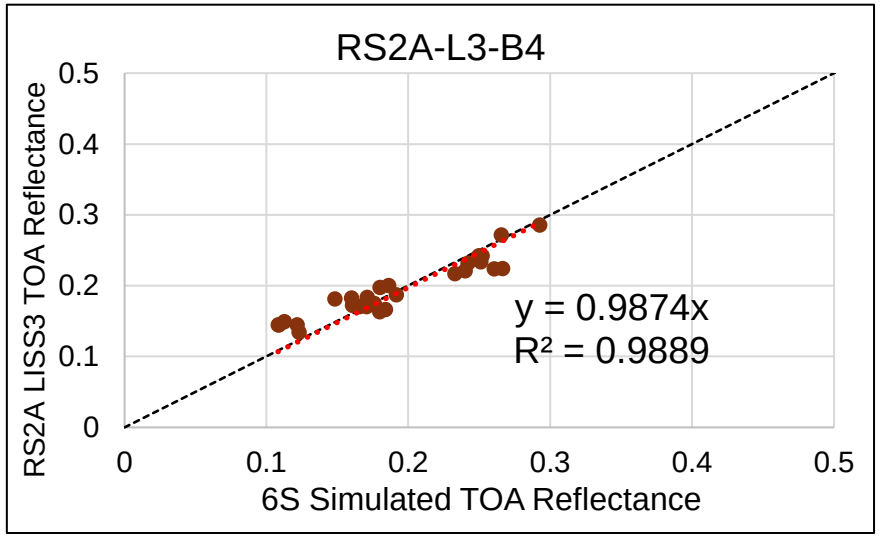
Absolute Calibration RS2A:LISS-3 @ Shadnagar site (2023-24)

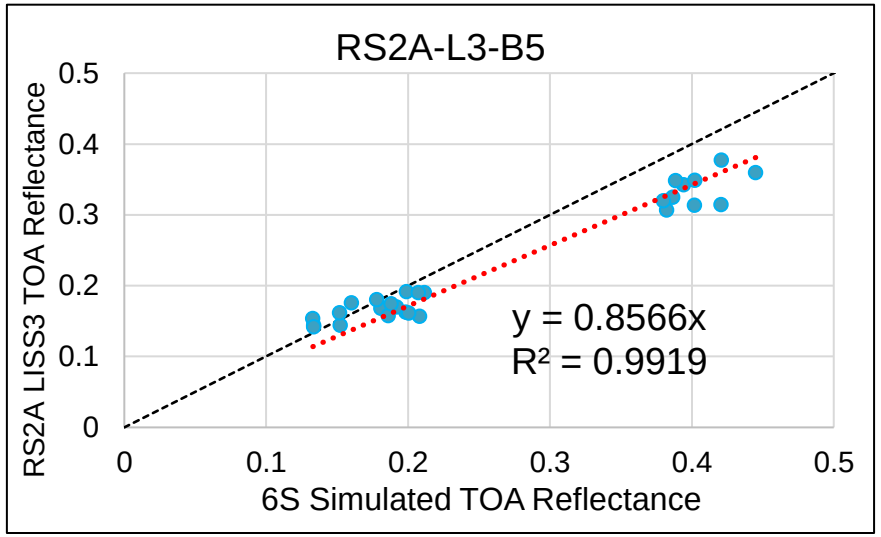


Ground Spectra of Targets Used

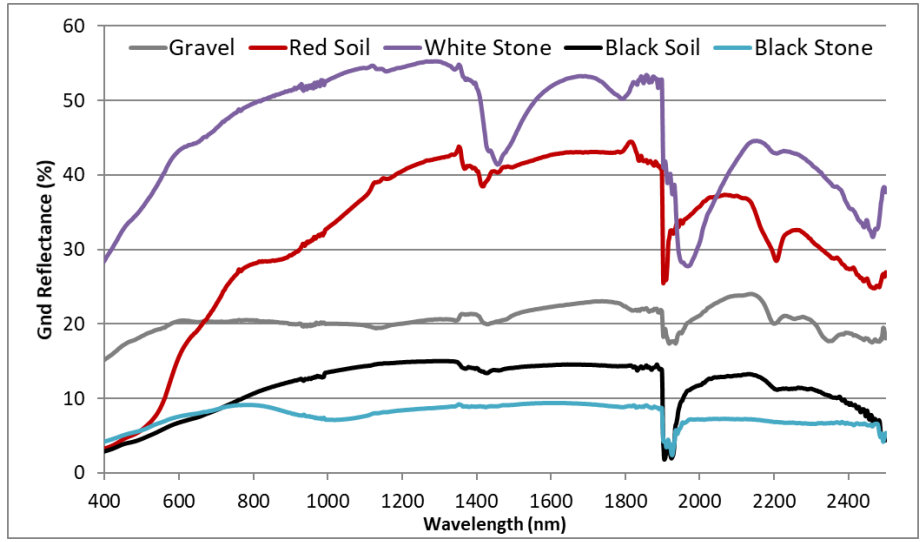


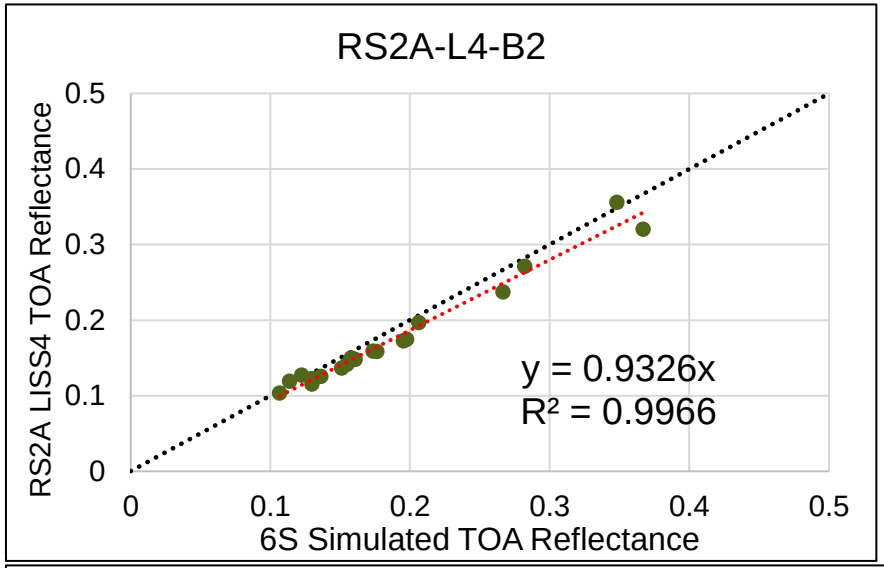


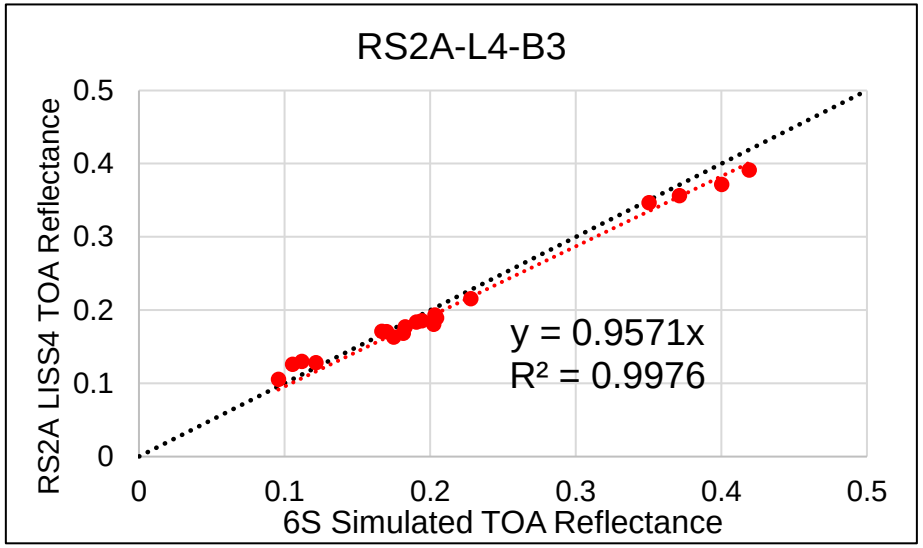


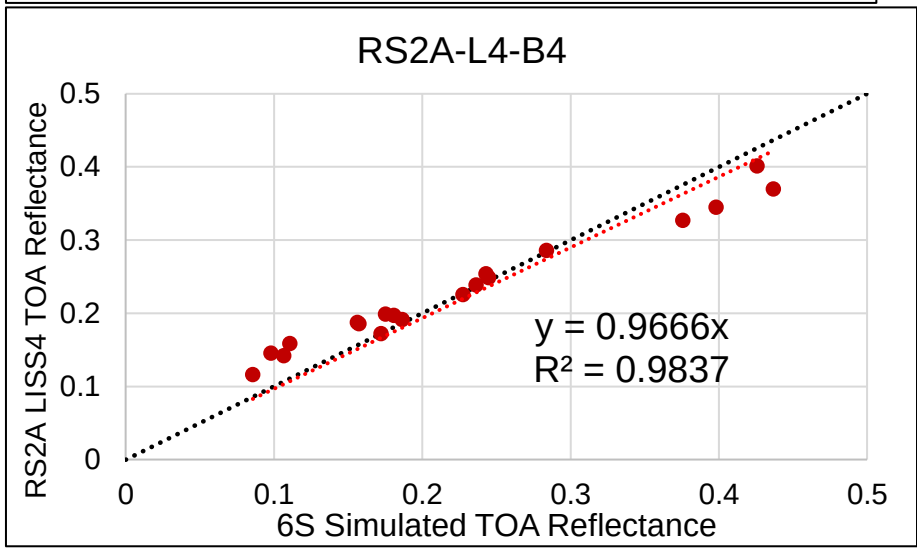


Absolute Calibration RS2A:LISS-4 @ Shadnagar site (2023-24)

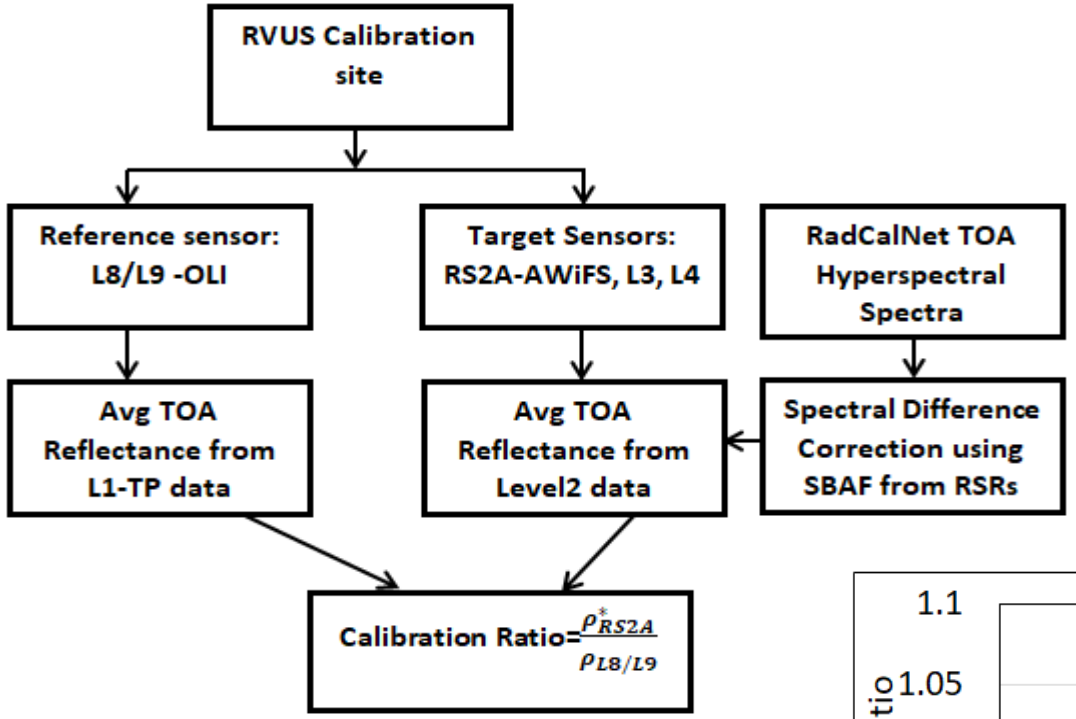




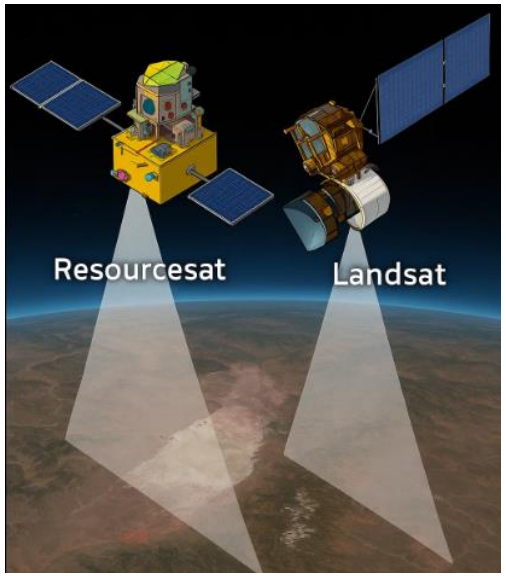


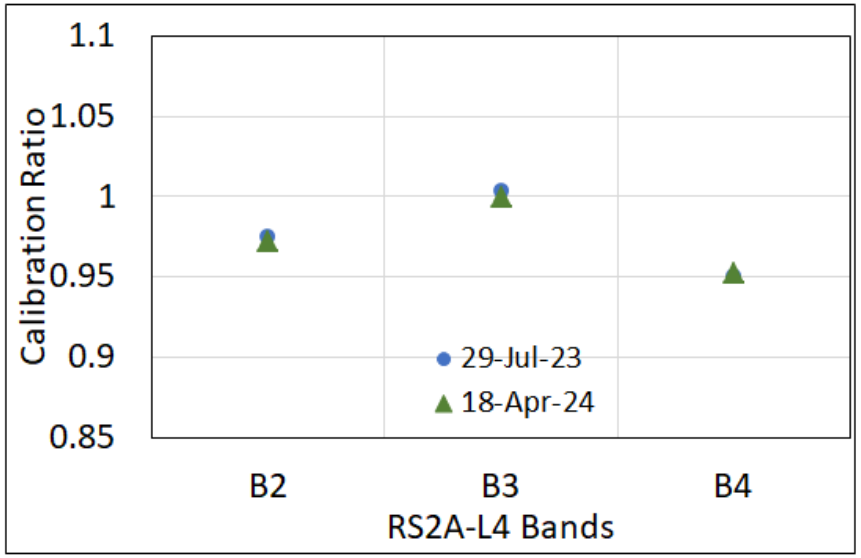


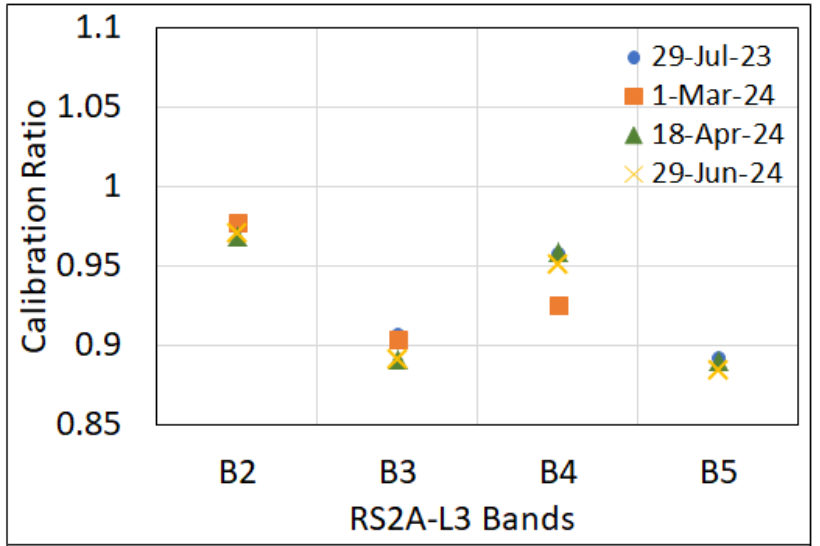
Cross Calibration RS2A Sensors with Landsat 8/9 OLI

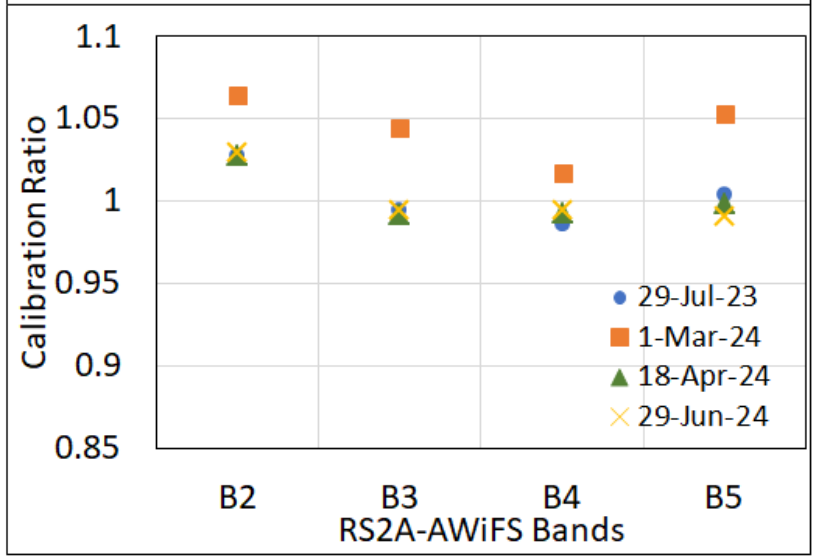


Date	Scene Time L8/L9	Scene Time RS2A
29-Jul-23	18:20:43	18:36:10
01-Mar-24	18:20:00	18:37:15
18-Apr-24	18:20:31	18:36:13
29-Jun-24	18:20:11	18:34:43



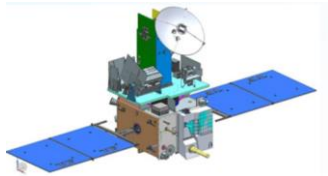






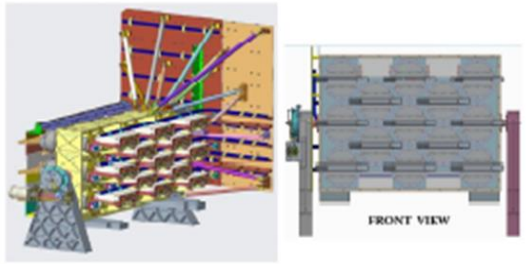
EOS-06: Ocean Color Monitor(OCM)-3

- Oceansat-3 (EOS-06), launched in November 2022, aims to maintain the continuity of services provided by Oceansat-2 while offering enhanced payload specifications and expanded application areas.
- External Time Delay and Integration (TDI) technique is employed to enhance the SNR requirements.
- Two imaging modes —Local Area Coverage (LAC) mode and Global Area Coverage (GAC) mode.
- Tilt condition of either + 20° or − 20° through a payload steering mechanism to avoid sun-glint



OCM-3 spectral bands and applications

Band definition (nm)	Applications
402–422	Yellow Substance Absorption
438–448	Low Chlorophyll, Yellow Substance
485–495	Moderate Chlorophyll, yellow substance
505–515	High Chlorophyll, Chlorophyll Species, TSM, Algal blooms
550–560	High Chlorophyll, Chlorophyll Species, TSM, Algal blooms
561–571	Phycoerythroblin pigment (PE), Trichodesmium bloom detection
615–625	Algal blooms, TSM
665–675	Algal Blooms, Baseline for Chlorophyll Fluorescence
677–685	Chlorophyll Fluorescence for high concentrations
705–715	Atmospheric Correction, Baseline for Chlorophyll Fluorescence
775–785	Atmospheric Correction
860–880	Atmospheric Correction
990–1030	Atmospheric Correction

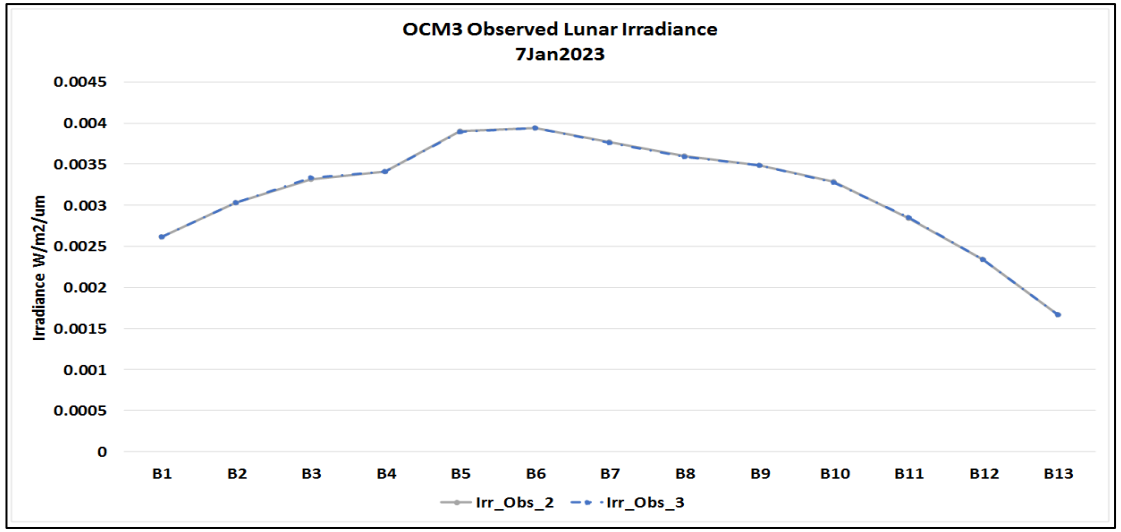


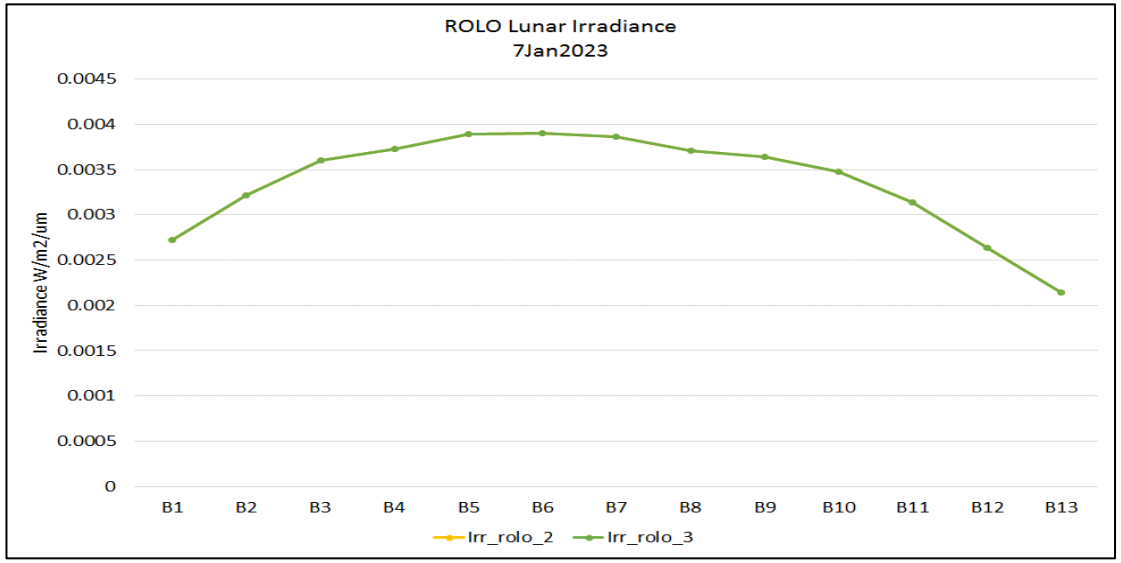
Parameter	Value
IGFOV at Nadir (m)	366 (LAC), 1100 (GAC)
Total lens assemblies and DHA	13
Optics focal length (mm)	20
Optics f-number	4.0 – 5.35
Field-of-View (°)	±43.5
Detector format (pixels)	4 k x 48 (useful: 3.8 k x 48)
Pixel size and pitch (µm)	10
Transmission bits	12 (LAC), 16 (GAC)
SNR at reference radiance	≥650 for B1 – B10 at 366m ≥500 for B1 – B13 at 1.1 km

Scatterometer-3 Specification

Parameter	Inner Beam / Outer Beam
Frequency	13.51 GHz
Swath / Polarization	1400/1800km (HH/VV)
One way 3dB foot print at Equatorial (Azi. x Ele.)	29.5 km x 20 km / 38 km x 22 km
Scan Rate	16 rpm
Antenna Diameter	1.4 m
Wind speed range	3 to 30 m/s
Wind direction range	0 to 360°
Wind speed accuracy	1.8 m/s rms or 10% whichever is higher
Wind direction accuracy	20o rms
Wind vector cell size	12.5 km x 12.5 km and 25 km x 25 km (LRScat) and 5 km x 5 km (HRScat)

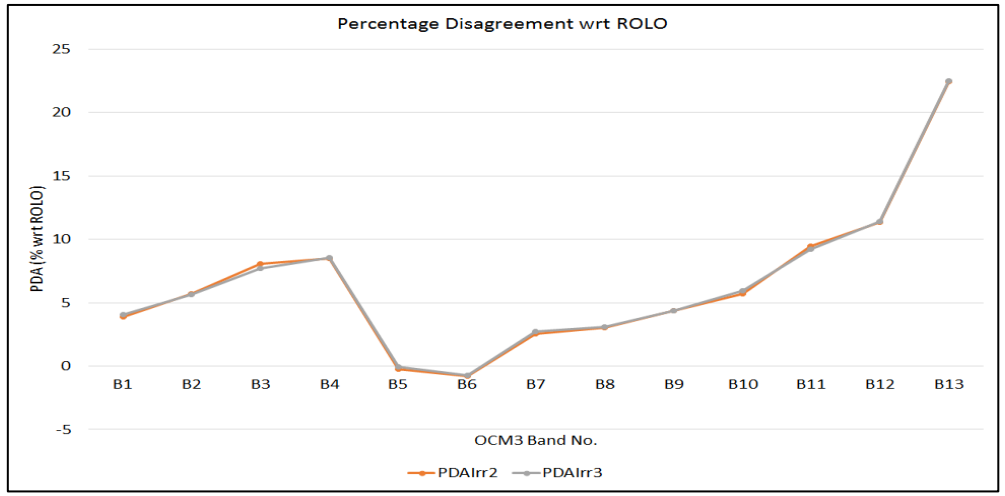
Lunar calibration of OCM3





Imaging parameters			
Date of Imaging/ Product Generation	Moon width/Height	Lunar Phase Angle (approx)	Central Lunar location (x,y)
07Jan2023/ 08Jan2023	28/23	5 deg	2766, 7174
	33/22		2767, 7319

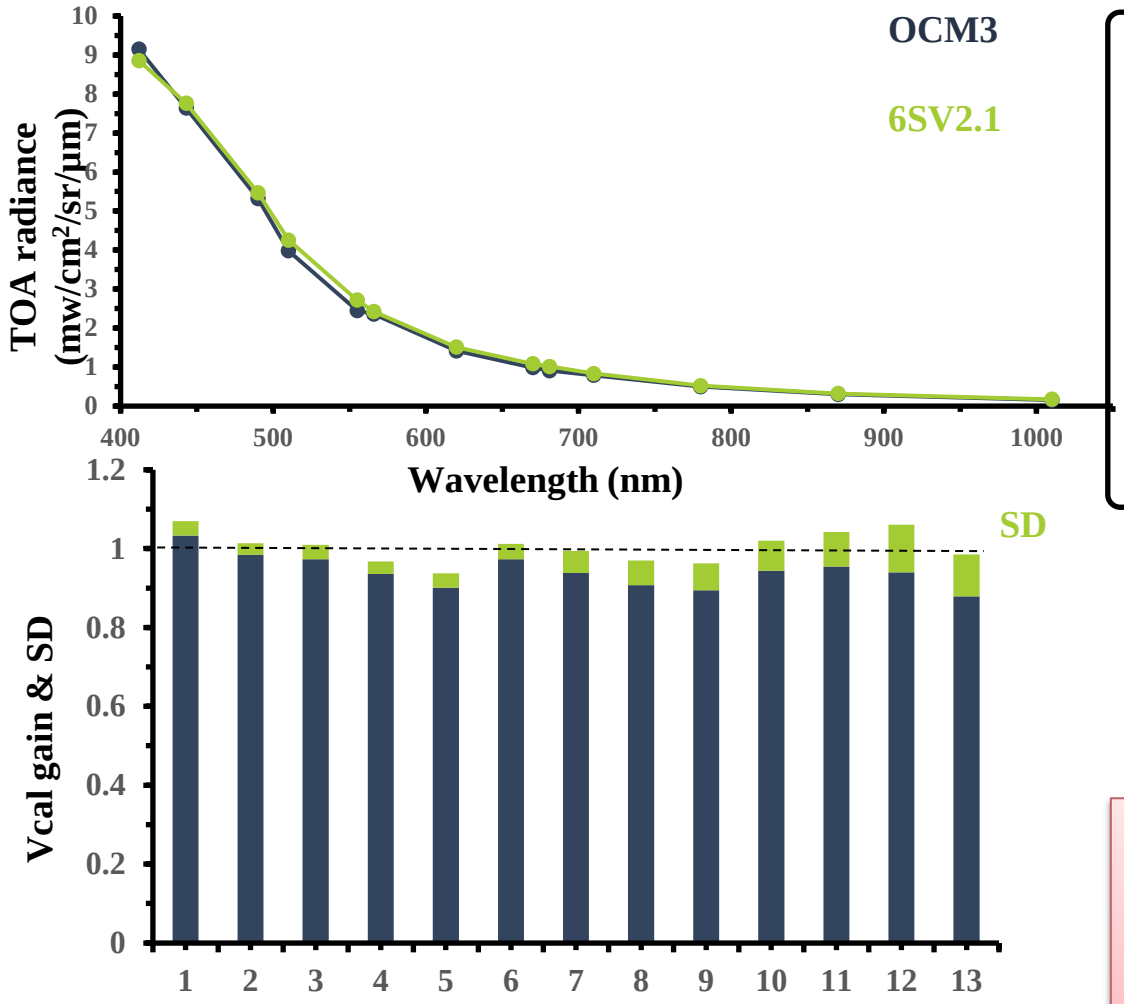
Two lunar images were processed by in-house developed MCAL software and the MCAL output, in netcdf format, was input to GIRO software for further processing.



- Two moon images of 7Jan2023 show close match with that of reference lunar irradiance
- The PDA is less than 10% for Band 1 to Band 11 of which B1,B5,B6 B7,B8 and B9 match within 5%
- The deep space threshold to identify moon pixels is the maximum dark count from deep space region

Desai, et. al., 2023

Ocean based vicarious calibration



Spectral surface reflectance

6SV RT Code

- Geometric conditions
- Atmospheric model
- TCO and WV
- Aerosol Model
- AOD
- Spectral Response Function

OCM3 TOA radiance

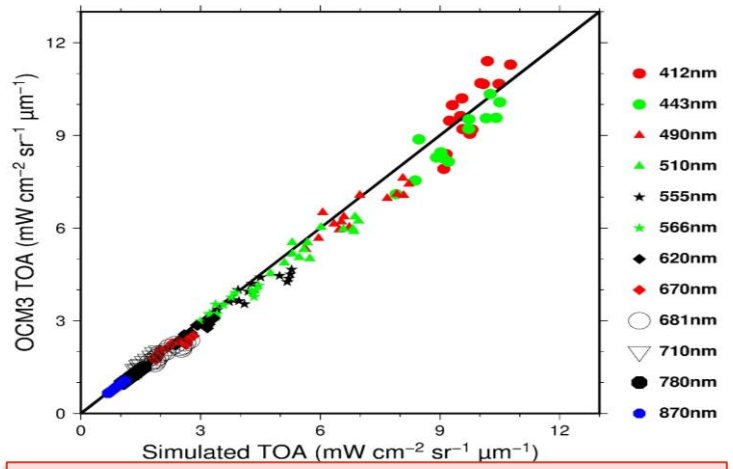
Simulated TOA radiance

Ocean VCal coefficients

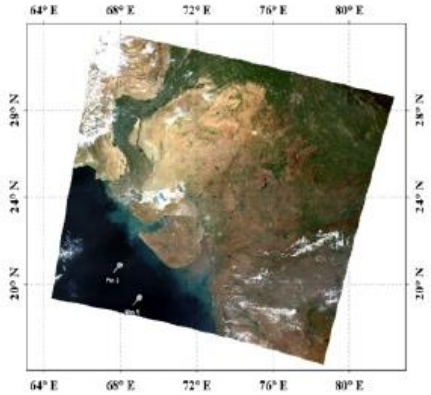
OCM3 vicarious calibration over Marine Optical Buoy (MOBY) site & Kavaratti site using 6SV2.1 RT model (**June. 2023 – Feb. 2024**)

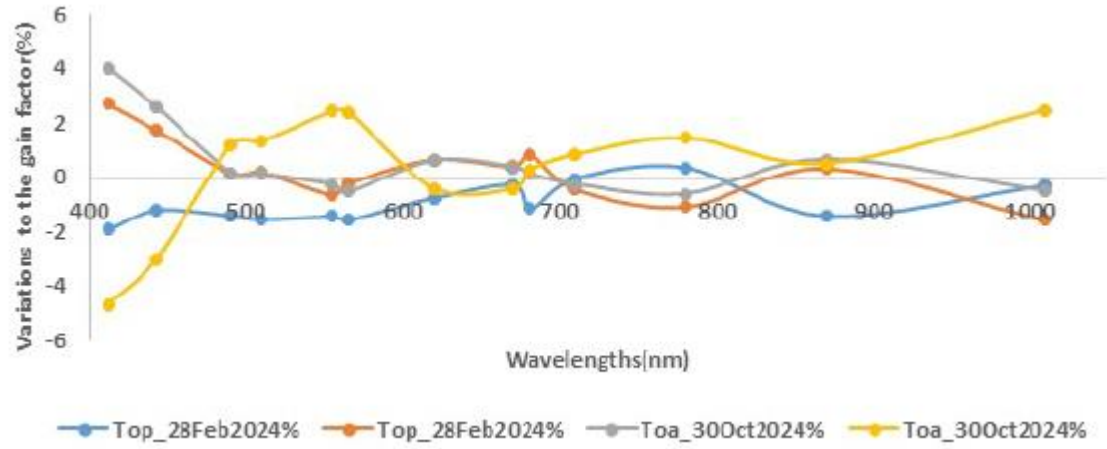
- The OCM3 scenes (qualified matchups) show close agreement with 6Sv2.1 simulation.
- The visible bands having small deviation, while the NIR bands having moderate standard deviation.
- The final Ocean Vcal coefficients are optimized for the uncertainty using cruise measurements.

Post launch calibration of OCM3 & verification through SVC



The scatter of simulated and OCM3 measured TOA radiance over Kavaratti site.





variations to the gain factors (%) across 412 to 1010 nm derived using Satellite Data Inversion (SDI) model

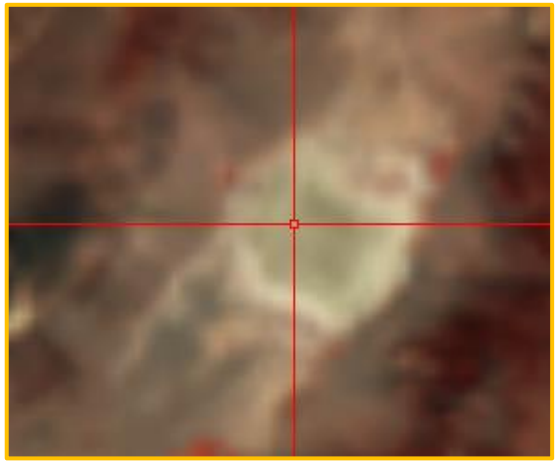
The mean vicarious calibration gain coefficients and its standard deviation in percentage over the bright target

Band (nm)	412	443	490	510	555	566	620	670	681	710	780	870
Gain	0.952	0.998	0.988	0.998	0.962	1.007	1.005	0.984	1.004	0.969	1.070	1.068
Std (%)	2.51	2.60	3.87	4.38	4.92	5.34	5.73	5.67	5.71	5.35	5.79	5.76

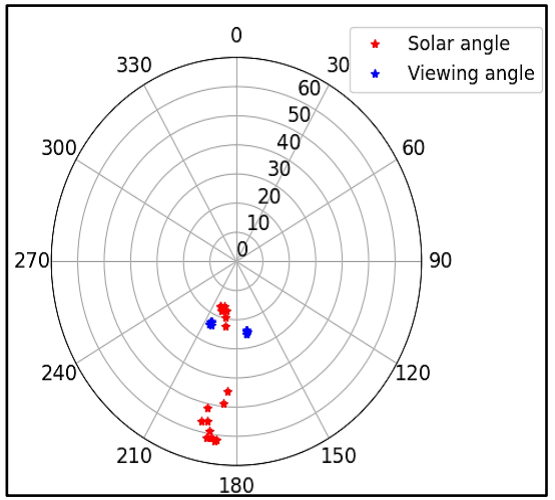
The percentage of relative difference is higher (~6%) for the chlorophyll channels (2-4) and its reference band (5) shows ~7%. The NIR channel of OCM3 showed 4 to 5% relative absolute difference between the simulated and measurements with 0.98 coefficient of correlation. The vicarious gain coefficients corrected TOA radiance of OCM3 radiance are closely matches with the simulation.

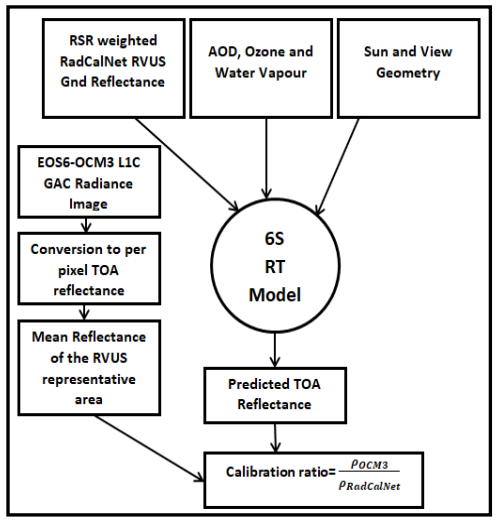
It is observed that out of thirteen channels of OCM, 490, 510, 620, 670, 681, 710, 780, and 870nm bands are found to be much stable as compared to the remaining i.e. 412, 443, 555, 566 and 1010 nm. Because these bands are having relatively less variations associated with the gain factor 1.5% with respect to their mean while others are in between 2 to 3% except 412 nm for which it is 4.7%.

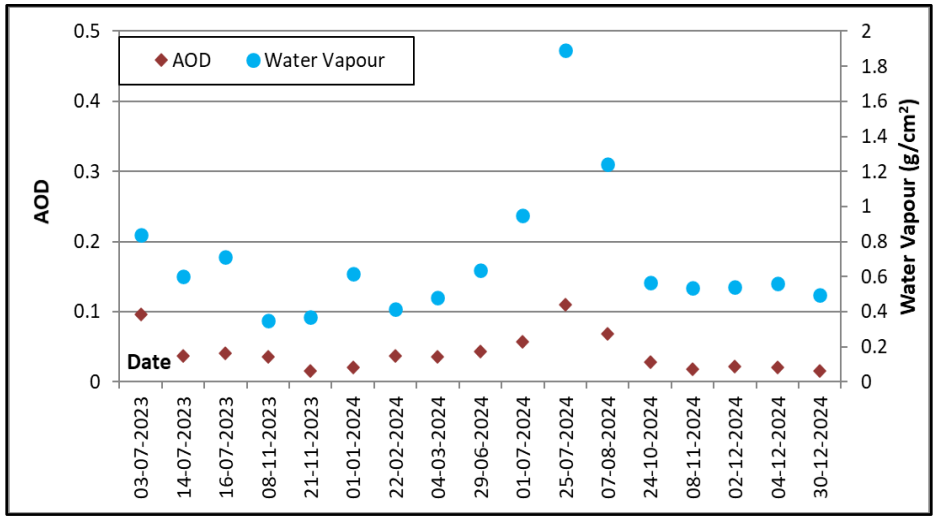
Absolute Calibration EOS6-OCM3 using RVUS (2023-24)

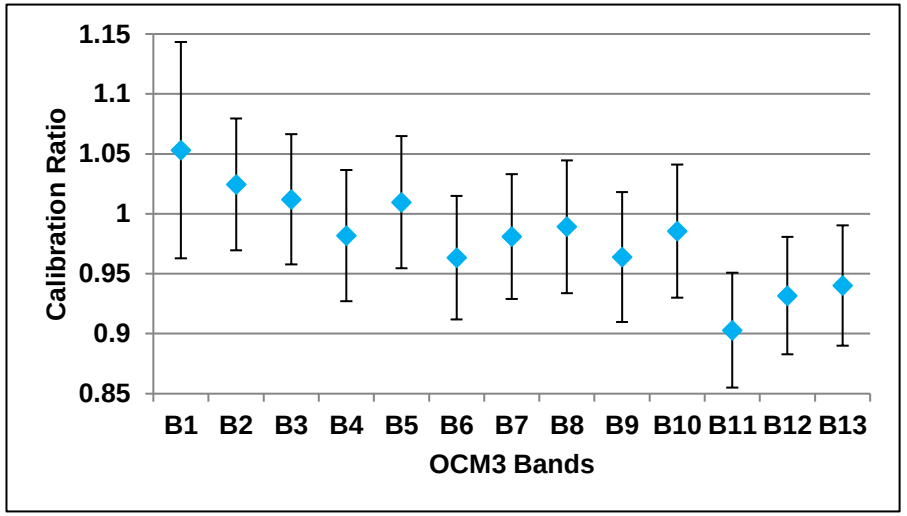


- RVUS site as imaged by OCM3 on 24 Oct 2024.
- 3kmx3km area was used for calibration which corresponds to 3x3 pixel in GAC Image
- Calibration Ratio calculated using 17 cloud free observations of OCM3 data from Jul'23 to Dec'24.
- Only observation with view angle <25° considered for analysis



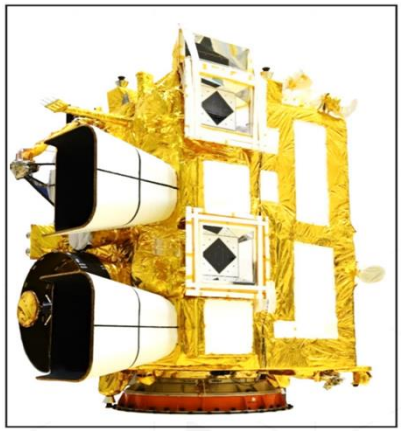






INSAT-3DS

- Launched on 17-Feb-2024 using GSLV-F14 rocket, from Satish Dhawan Space Centre (SDSC/ISRO)
- Improvements to mitigate the issues related to the blackbody calibration and mid-night sun-intrusion
- **INSAT-3DS replaced INSAT-3D at 82 ºE**

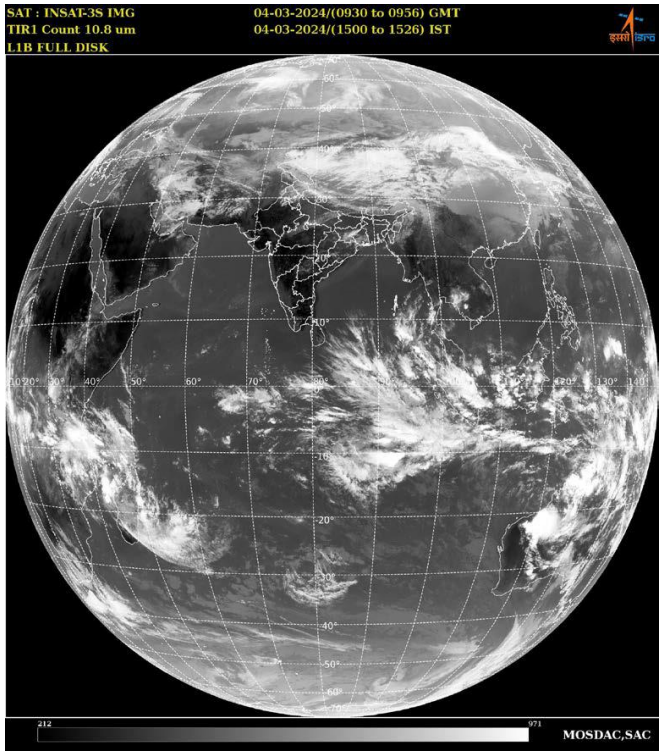


6-Channel Imager

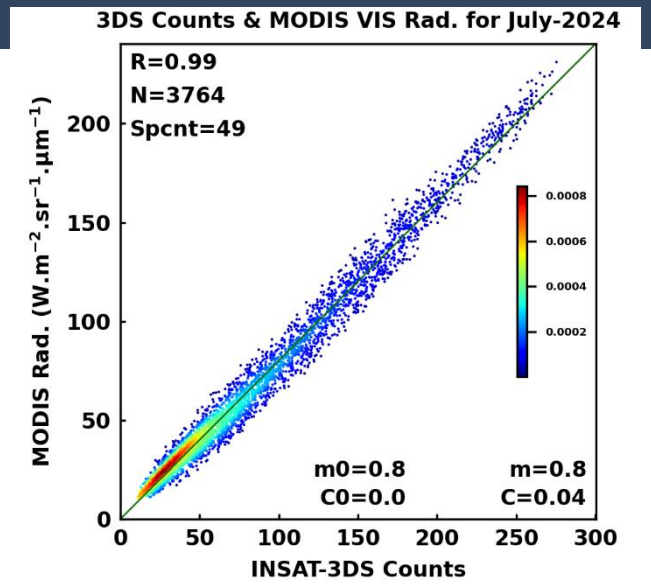
Channel	Spectral Band (µm)	Spatial Resolution at Nadir (km)	SNR @ 100% or NEΔT@300K
VIS	0.55-0.75	1 km	SNR>150
SWIR	1.55-1.68	1 km	SNR>150
MIR	3.80-4.00	4 km	1.4K
WV	6.5-7.1	8 km	1.0K@230K
TIR-1	10.3-11.3	4 km	0.35K
TIR-2	11.5-12.5	4 km	0.35K

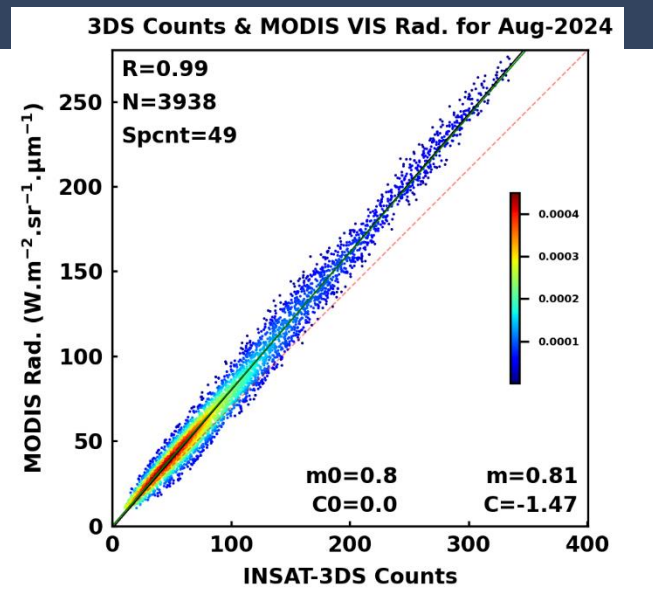
19 - Channel Sounder (18 IR + 1 VIS)

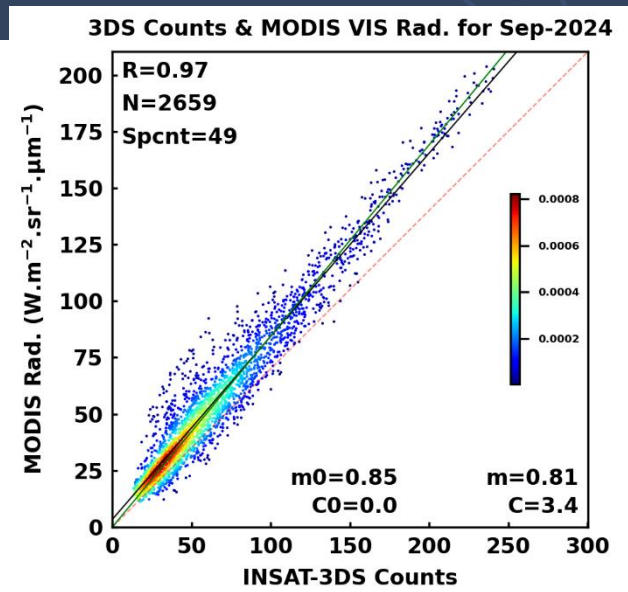
Detector	Ch. No.	λ_c (µm)	ν_c (cm^{-1})	Principal absorbing gas	Purpose
Long wave	1	14.68	681	CO_2	Stratosphere temperature
	2	14.36	696	CO_2	Tropopause temperature
	3	14.06	711	CO_2	Upper-level temperature
	4	13.69	731	CO_2	Mid-level temperature
	5	13.35	749	CO_2	Low-level temperature
	6	12.63	792	H_2O	Total precipitable water
	7	12.01	833	H_2O	Surface temp., moisture
Mid wave	8	11.00	909	Window	Surface temperature
	9	9.72	1029	O_3	Total ozone
	10	7.43	1347	H_2O	Low-level moisture
	11	7.03	1422	H_2O	Mid-level moisture
	12	6.51	1537	H_2O	Upper-level moisture
Short wave	13	4.60	2174	N_2O	Low-level temperature
	14	4.55	2200	N_2O	Mid-level temperature
	15	4.48	2235	CO_2	Upper-level temperature
	16	4.16	2404	CO_2	Boundary-level temperature
	17	4.01	2493	window	Surface temperature
	18	3.76	2659	window	Surface temperature, moisture
Visible	19	0.695	14367	visible	Cloud detection during daytime

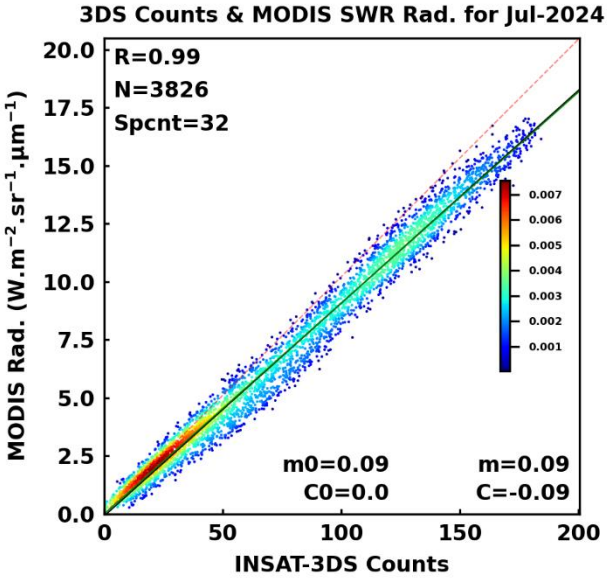


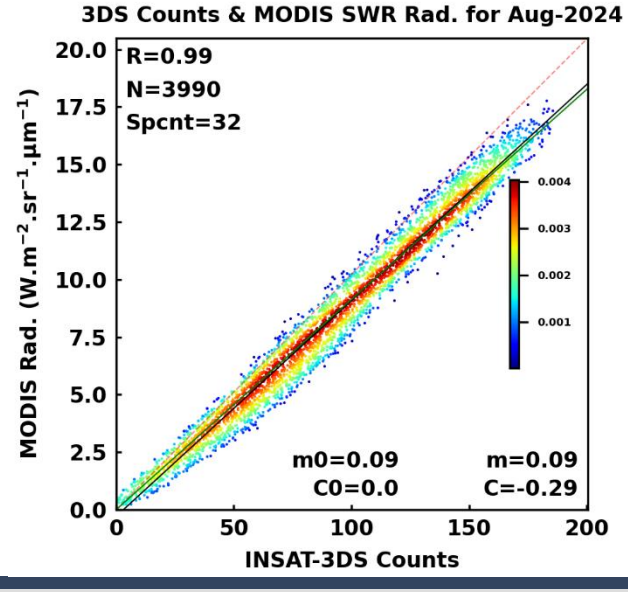
INSAT-3DS Imager Counts and MODIS Radiance for VIS & SWIR Channels

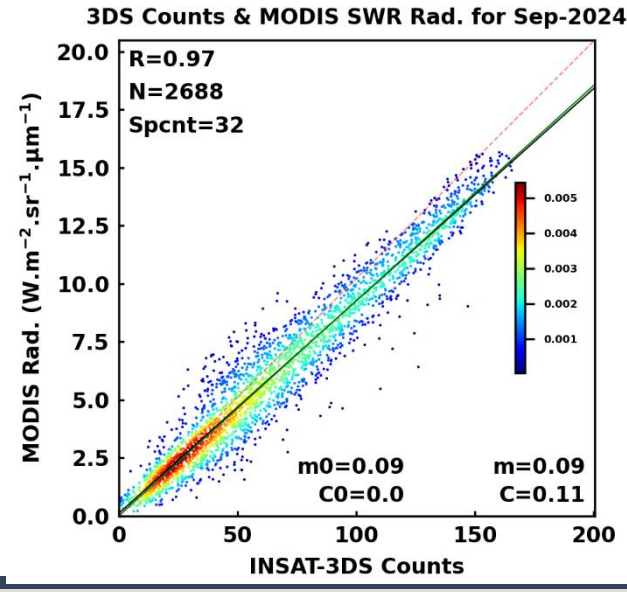




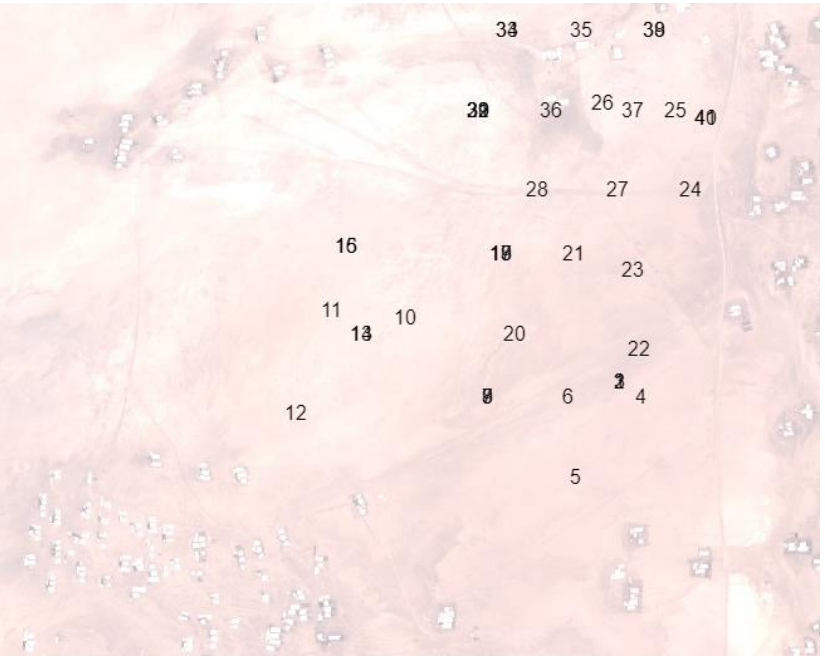




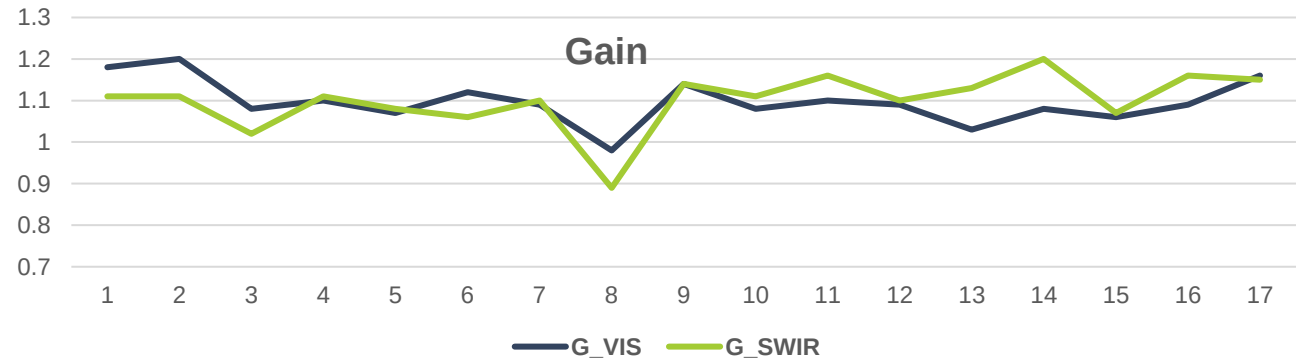




INSAT-3DS Imager



Date	TIME (GMT)	Lat	Lon	6S_VIS	6S_SWIR	VIS	SWIR	gain_vis	gain_swir
20-03-24	'0659'	23.354	71.440	9.71	2.08	8.21	1.88	1.18	1.11
20-03-24	'0659'	23.354	71.440	9.83	2.08	8.21	1.88	1.20	1.11
20-03-24	'0659'	23.349	71.448	8.86	1.88	8.21	1.84	1.08	1.02
20-03-24	'0659'	23.341	71.449	9.06	2.03	8.21	1.84	1.10	1.11
20-03-24	'0659'	23.348	71.416	8.92	2.01	8.34	1.86	1.07	1.08
20-03-24	'0629'	23.343	71.443	9.63	2.05	8.60	1.94	1.12	1.06
20-03-24	'0629'	23.343	71.434	9.42	2.06	8.60	1.88	1.09	1.10
20-03-24	'0629'	23.337	71.422	8.56	1.73	8.73	1.95	0.98	0.89
20-03-24	'0629'	23.334	71.442	9.60	2.26	8.41	1.97	1.14	1.14
20-03-24	'0629'	23.325	71.438	9.06	2.00	8.41	1.81	1.08	1.11
20-03-24	'0629'	23.317	71.435	9.56	2.08	8.67	1.79	1.10	1.16
20-03-24	'0559'	23.333	71.418	9.20	2.02	8.41	1.84	1.09	1.10
20-03-24	'0559'	23.325	71.416	8.62	2.09	8.41	1.84	1.03	1.13
20-03-24	'0559'	23.325	71.416	9.07	2.21	8.41	1.84	1.08	1.20
20-03-24	'0559'	23.329	71.430	8.68	1.89	8.21	1.77	1.06	1.07
20-03-24	'0559'	23.326	71.403	9.69	2.10	8.87	1.80	1.09	1.16
20-03-24	'0559'	23.323	71.424	9.59	2.05	8.28	1.77	1.16	1.15
-	-	-	-	**9.24**	**2.04**	**8.42**	**1.85**	**1.10**	**1.10**
				6S_VIS	6S_SWIR	VIS	SWIR	Gain_Vis	Gain_Swir



Gain derived from reflectance measurements over Little Rann of Kutch on 20Mar2024 (observations filtered between 0600 to 0700 GMT and over homogeneous regions)

Gain for VIS and SWIR bands derived from Imager TOA radiance and simulated (6S TOA radiance).

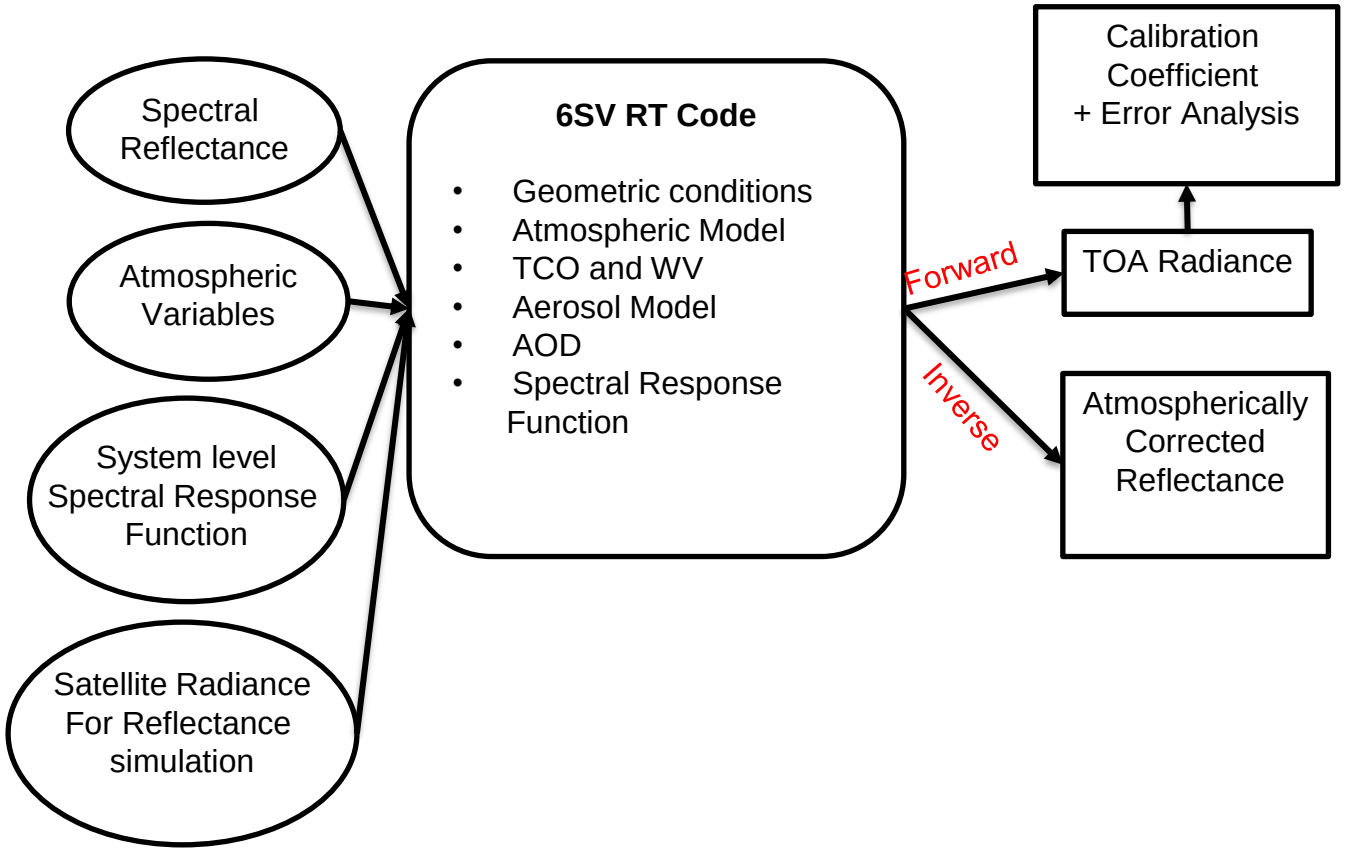
Vicarious Calibration Results for INSAT-3DS and INSAT-3DR

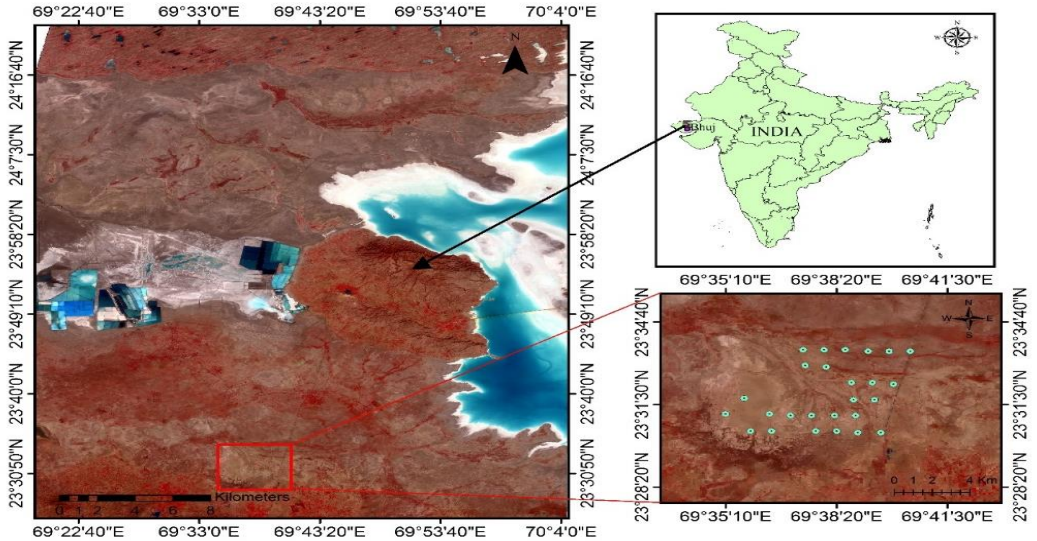
Date	Time (GMT)	Points	Lat	Lon	INSAT_3DS	Gain_VIS	Gain_SWIR		INSAT_3DR	Gain_VIS	Gain_SWIR
01-01-25	6	1	23.30797	71.43459		1.11	0.84			1.05	0.78
01-01-25	630	2	23.31562	71.42627		1.18	1.13			1.15	1.08
01-01-25	630	3	23.322	71.42082		1.21	1.09			1.21	1.04
01-01-25	630	4	23.32983	71.42383		1.24	1.14			1.27	1.10
01-01-25	630	5	23.32588	71.42832		1.1	0.89			1.07	0.85
01-01-25	630	6	23.33204	71.42765		1.41	1.29			1.39	1.22
09-01-25	6	16	23.32345	71.42242		1.06	0.93			1.07	0.87
09-01-25	6	17	23.32075	71.4181		1.1	0.95			1.09	0.86
09-01-25	6	18	23.31793	71.41345		1.17	1.01			1.14	0.93
09-01-25	630	19	23.32055	71.41247		1.18	1.1			1.14	1.01
09-01-25	630	20	23.32095	71.41513		1.14	0.97			1.11	0.89
09-01-25	630	22	23.32187	71.4209		1.14	1.03			1.09	0.94
09-01-25	7	23	23.32197	71.42087		1.12	0.96			1.11	0.95
09-01-25	7	24	23.32488	71.42188		1.12	1.06			1.09	1.05
09-01-25	7	25	23.32667	71.42433		1	0.87			0.97	0.86
					Mean	**1.15**	**1.02**		**Mean**	**1.13**	**0.96**
					Std	**0.09**	**0.09**		**Std**	**0.10**	**0.12**
					Mean+(1.5*Std)	**1.29**	**1.16**		**Mean+(1.5*Std)**	**1.28**	**1.14**
					Mean-(1.5*Std)	**1.01**	**0.88**		**Mean-(1.5*Std)**	**0.98**	**0.78**
					INSAT_3DS	**Gain_VIS**	**Gain_SWIR**		**INSAT_3DR**	**Gain_VIS**	**Gain_SWIR**
					FINAL_Mean	**1.14**	**1.02**		**FINAL_Mean**	**1.12**	**0.96**
					Stdev	**0.05**	**0.08**		**Stdev**	**0.06**	**0.09**

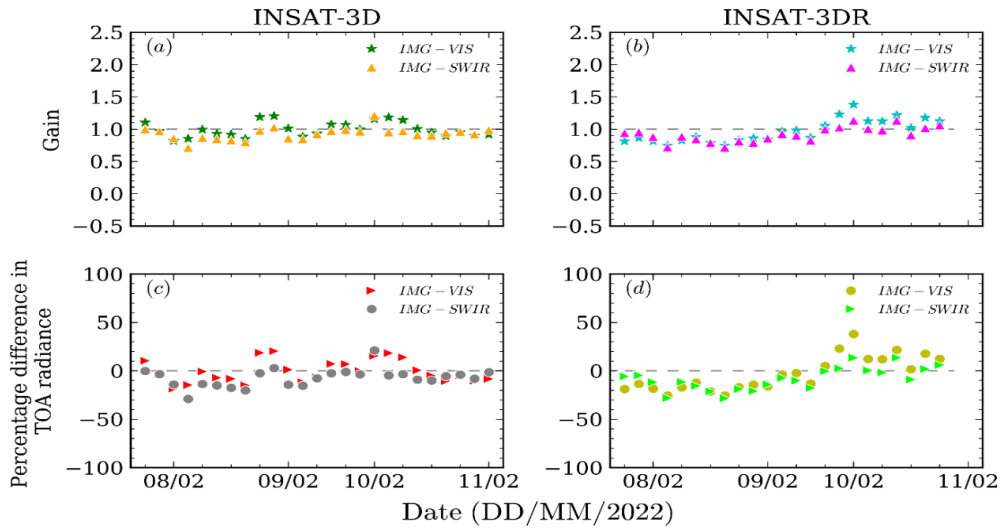
$$\text{mean} = \frac{\sum_i (1.5*\sigma - \bar{X}) < X_i < (1.5*\sigma + \bar{X})}{N}$$

Saurabh, Danish Hussain, Sanjib K. Deb

Radiometric Vicarious Calibration of GEO Satellites: INSAT-3D and -3DR



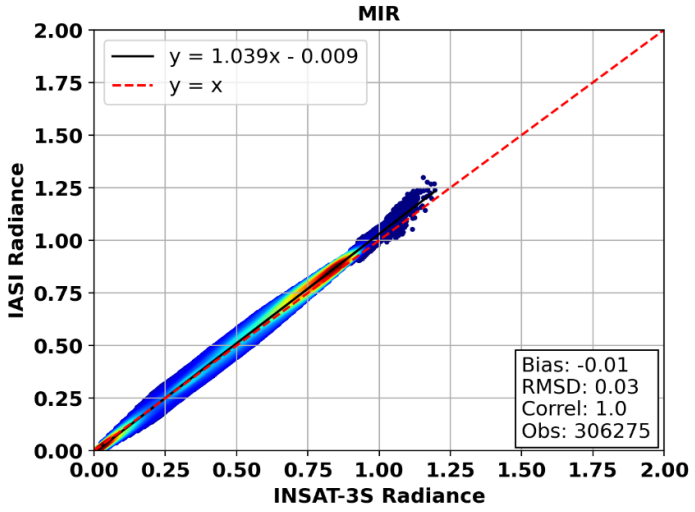


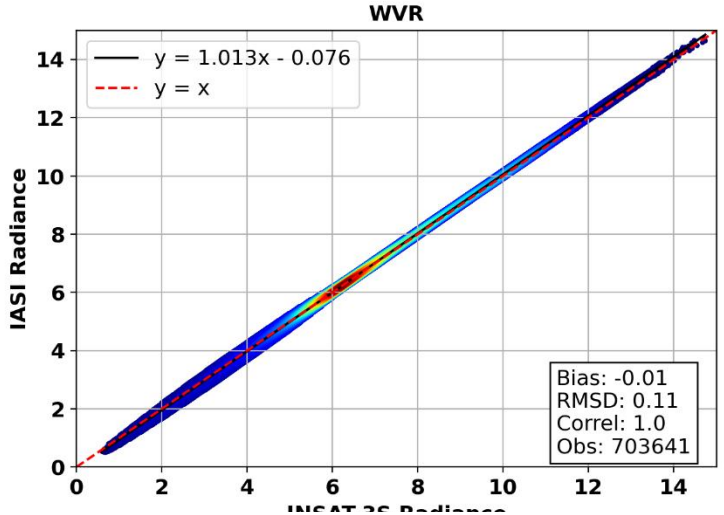


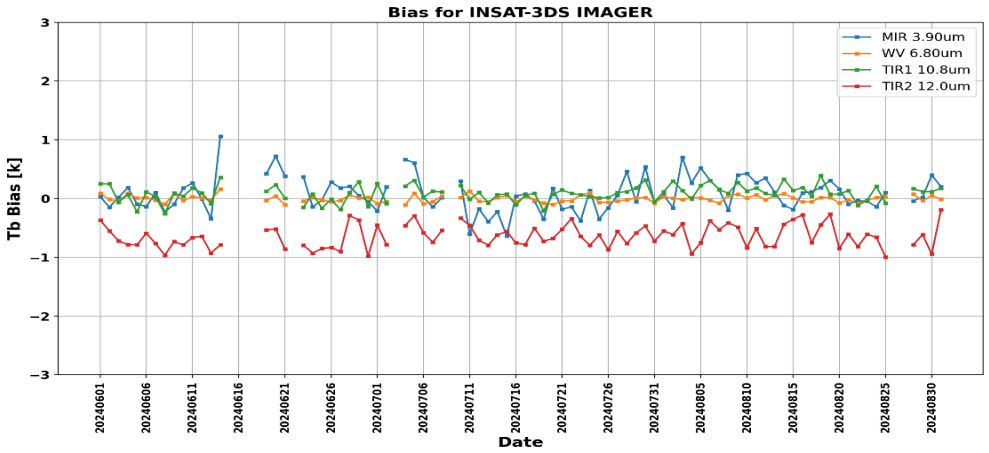
Top panel: Gain for VIS and SWIR bands derived from IMAGER TOA radiance and simulated (6S TOA radiance).

Bottom panel: The percentage difference in TOA radiance determined using (INSAT– 6SV)/6SV.

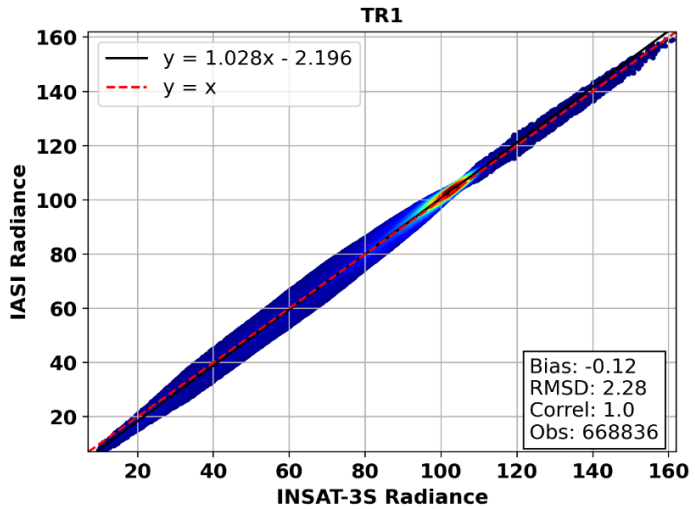
Inter-Calibration Outcomes: INSAT-3DS IMAGER (Jun-Aug, 2024)

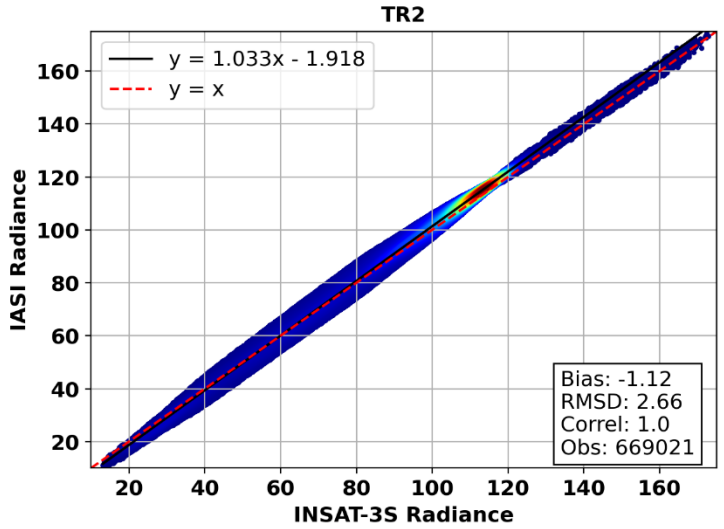


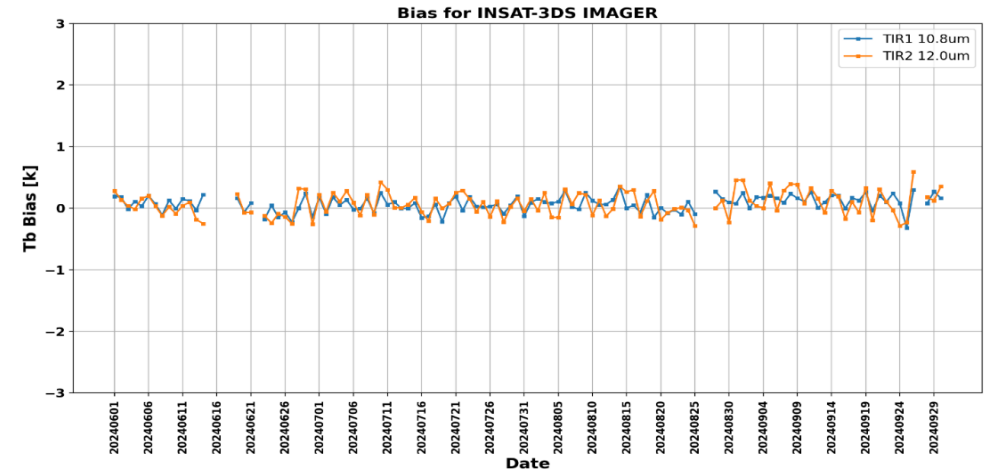




After GSICS Correction

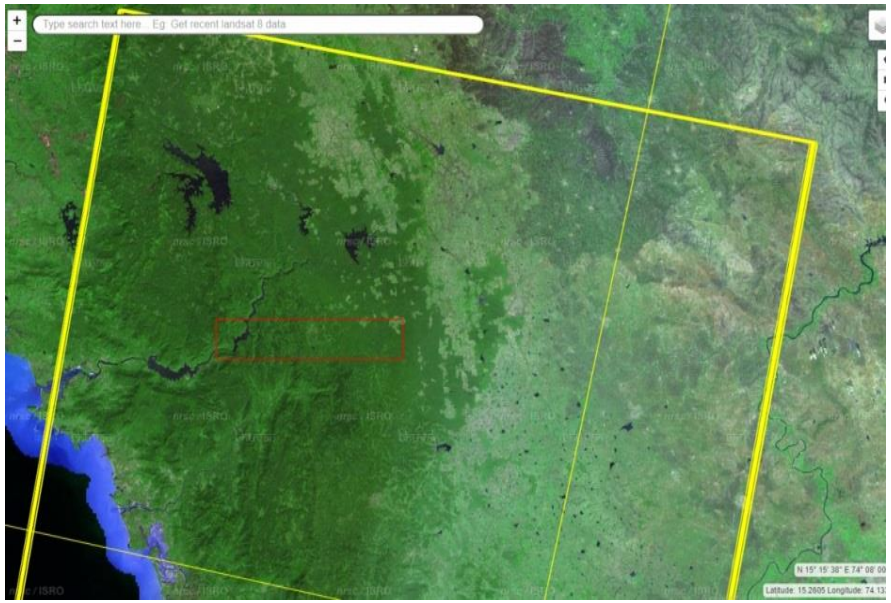




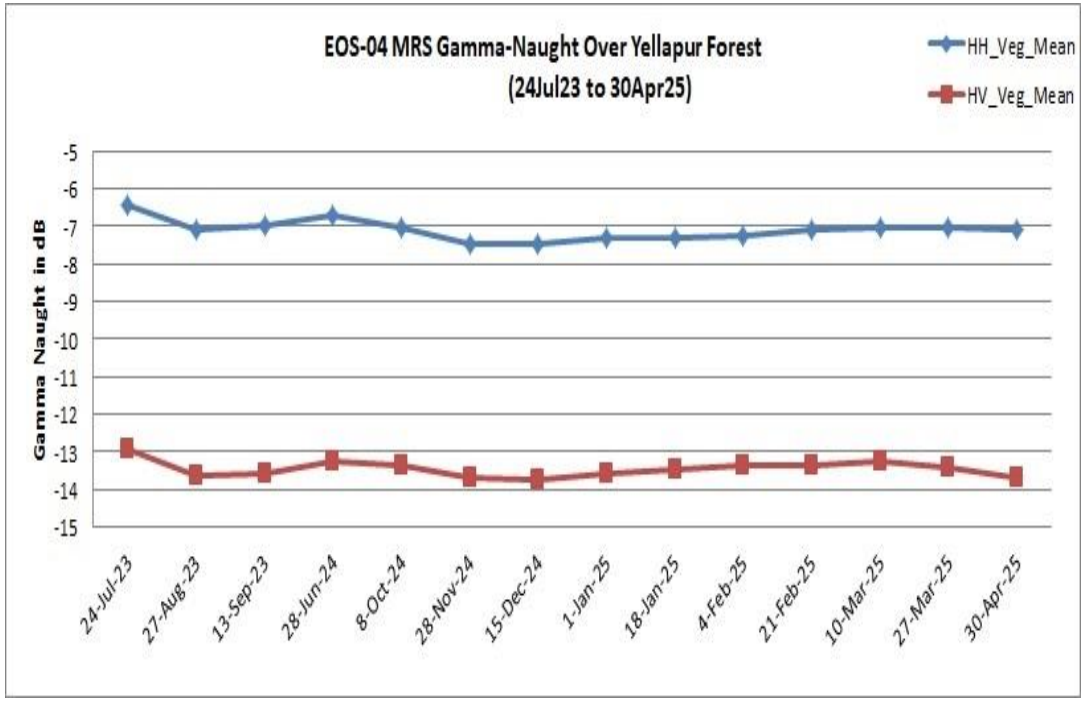


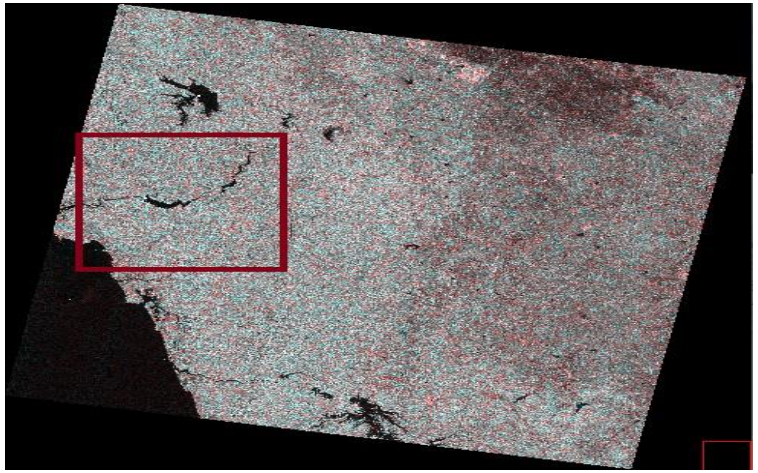
*Bias and RMSD are derived from x - y

Radiometric response monitoring-Yellapur Forest



Study area:



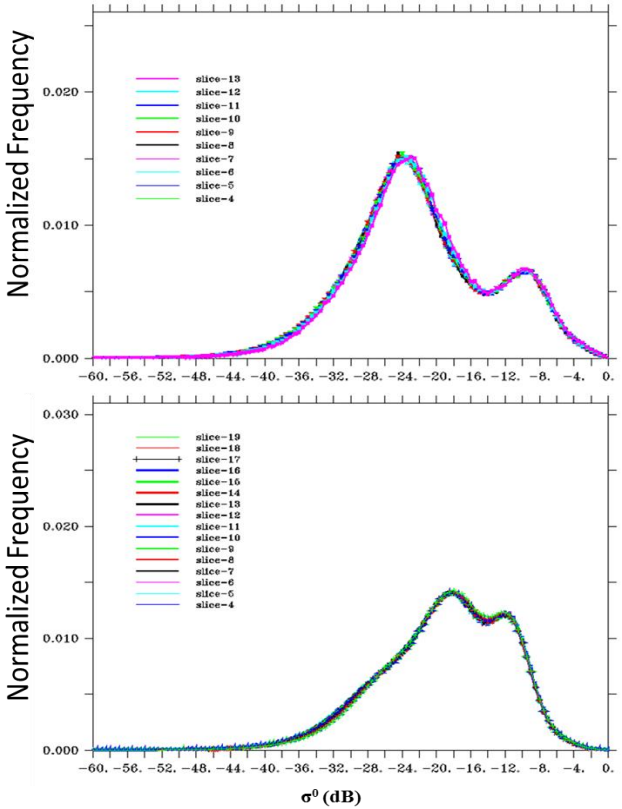


Yellapur Forest Gamma Naught in dB		
EOS-04 MRS	**HH**	**HV**
Max	-6.43	-12.94
Min	-7.45	-13.75
Range	1.03	0.81
Mean	**-7.08**	**-13.45**
Std.Dev	0.28	0.22
CV	-0.04	-0.02

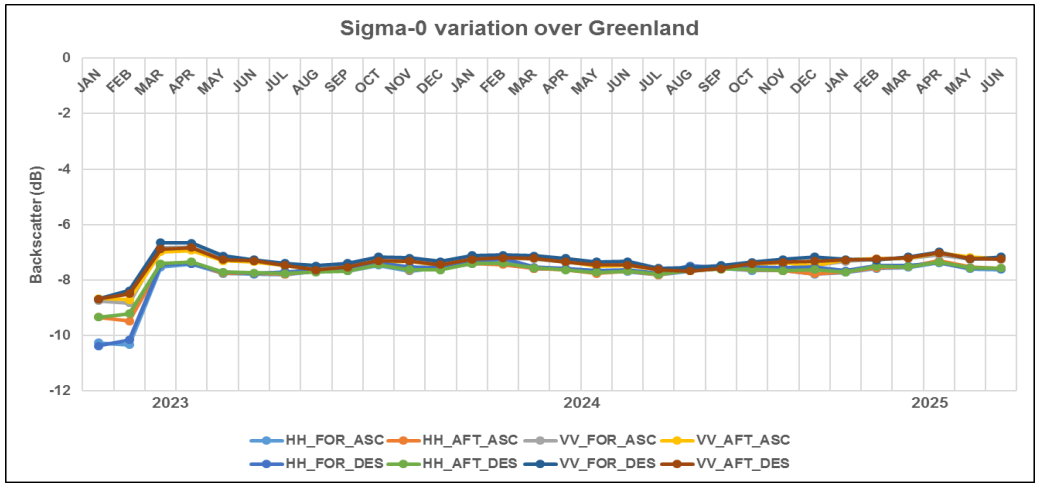
Gamma Naught values in co-polarisation and cross polarisation are consistent with temporal coefficient of variation -0.04 in co-pol and -0.02 in cross-pol.

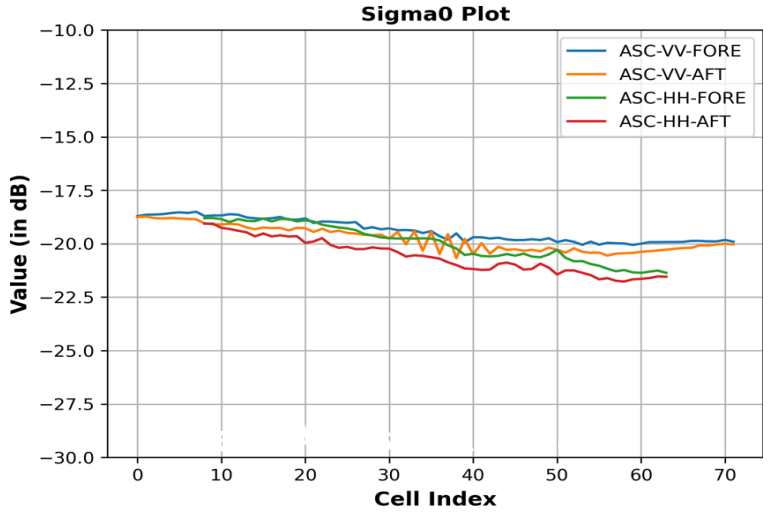
Long term stability of backscatter over CAL site of Greenland

Slice balancing using histogram peak matching technique



Histogram of global σ0 from a) inner (HH) and b) outer (VV) descending passes with aft looks from EOS-06 for March 2024.

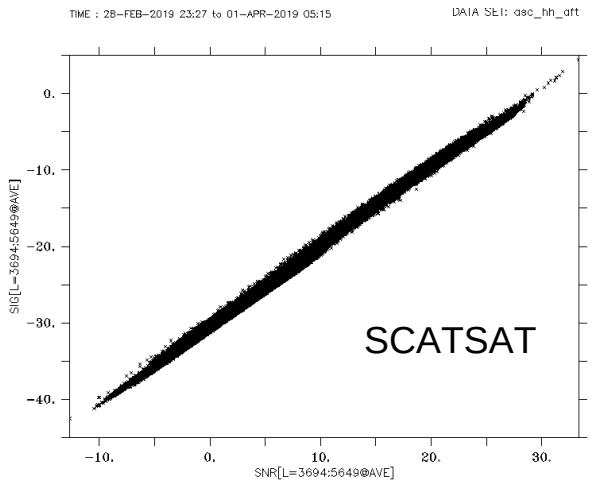


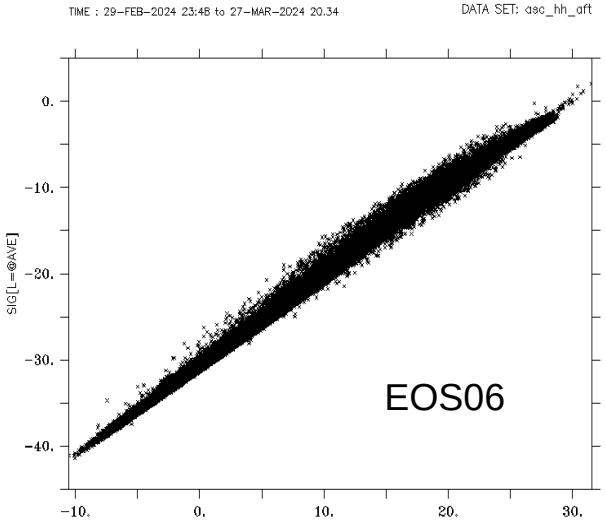


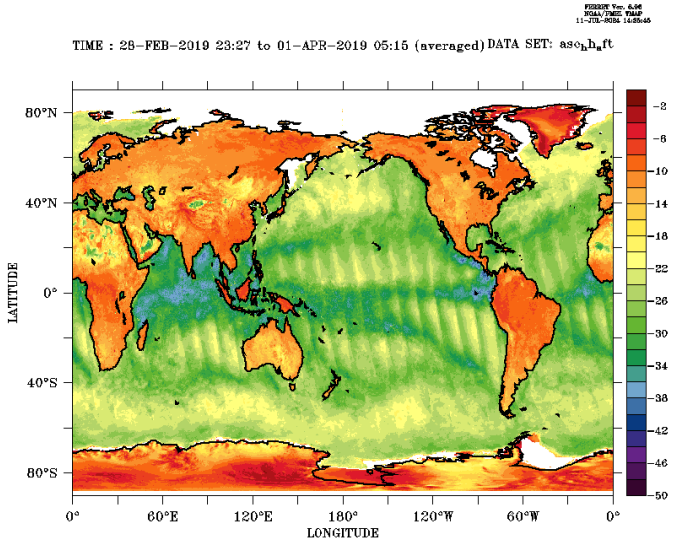
- ✓ This component of CAL chain uses the EOS-06 slice-level σ^0 from L1B.
- ✓ EOS-06 instantaneous foot print is an ellipse. For the inner beam the foot print is divided into 16 slices and for outer beam it is 22 slices.
- ✓ Overall quality of measured σ^0 of EOS06 is determined by the distribution of σ^0 over various slices for both the inner and outer beams.
- ✓ This is done at a global scale by constructing the histogram of σ^0 for each slice. Thus the probability of measurements over full dynamic range of σ^0 for all slices is similar and therefore histograms of all slices should peak at a same value of σ^0.

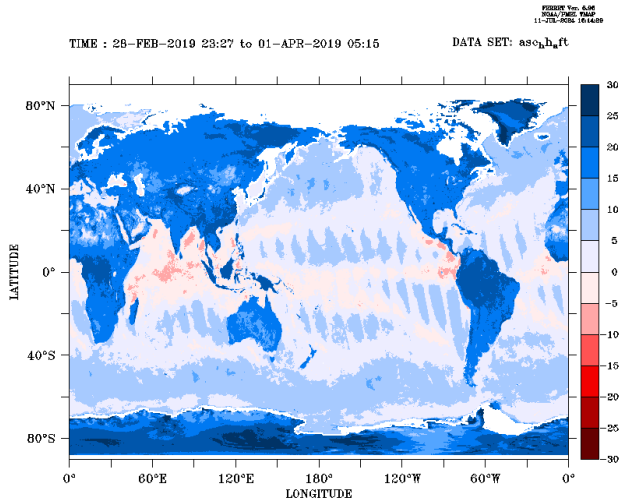
EOS-06 σ^0 peak over both ocean and land matches fairly between its beams.

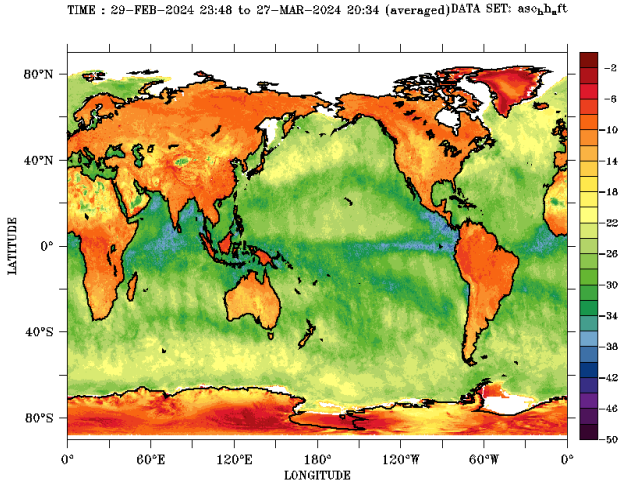
Cross Calibration using SCATSAT-1

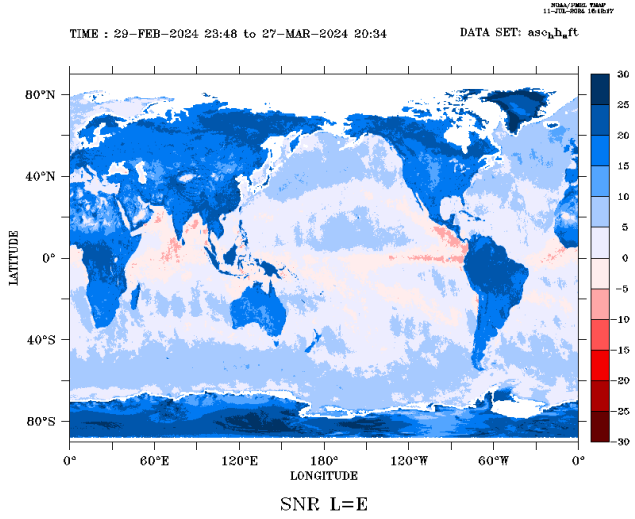








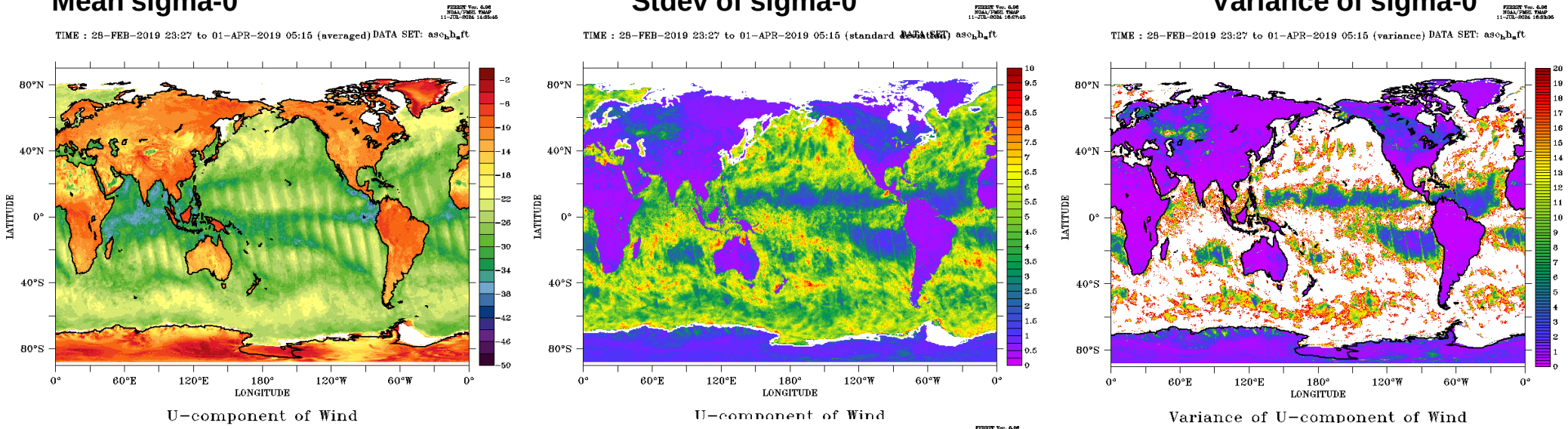




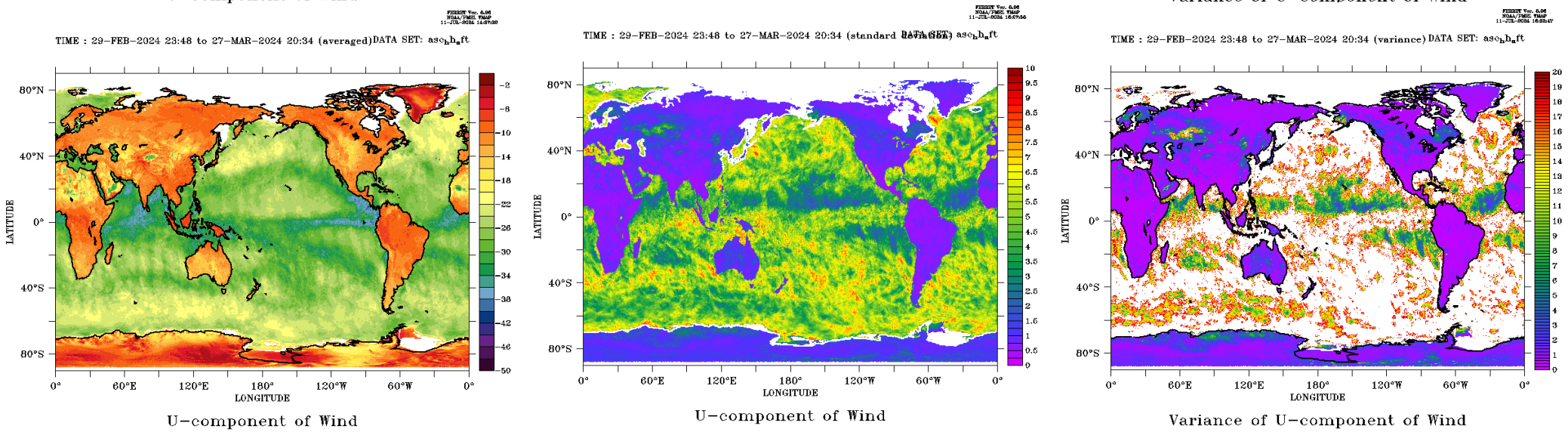
Cross Calibration using SCATSAT-1

Mean sigma-0 | **Stdev of sigma-0** | **Variance of sigma-0**

SCATSAT MARCH 2019



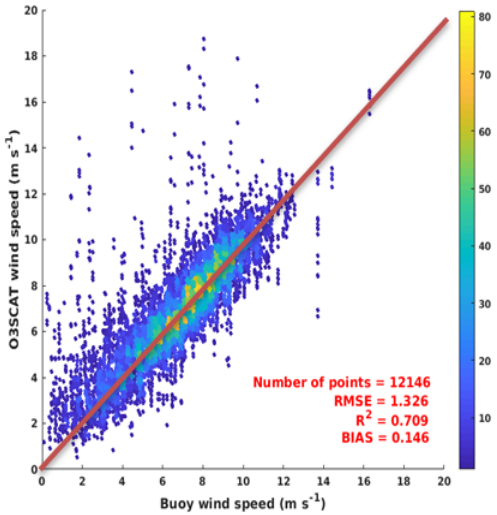
EOS06 MARCH 2024

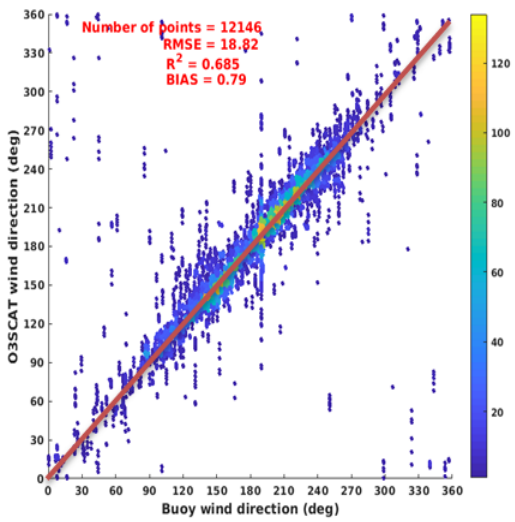


Suchandra, et. al., 2025

Comparison with other sources

Comparison with TAO/TRITON/RAMA and OMNI Buoy data



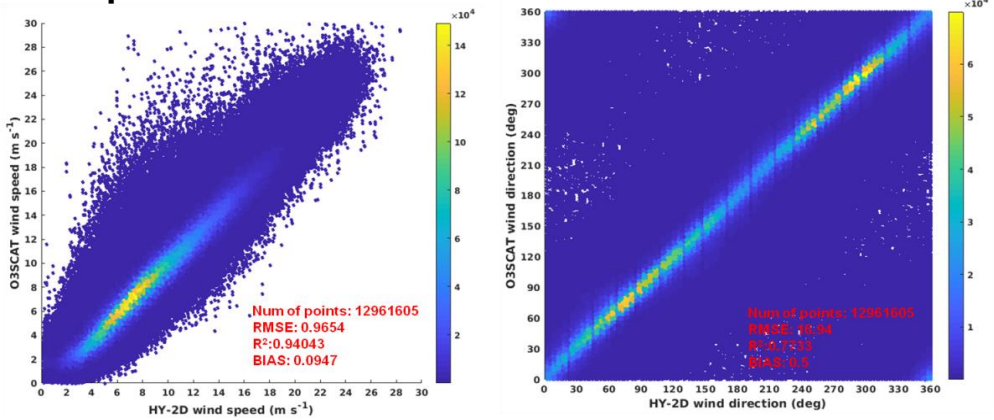


Density scatterplot of comparison between EOS-06 Scat wind speed and wind direction with buoy data. Collocated data from May 2023 to December 2023 were used for this comparison.

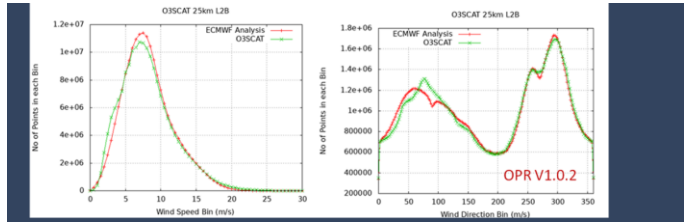
EOS-06 offers wind vector with accuracy of:

- 1.32 m/s and 18.8 deg wrt. buoy
- 0.96m/s and 16.9 deg wrt HY2D
- 1.25m/s and 14 deg wrt ECMW

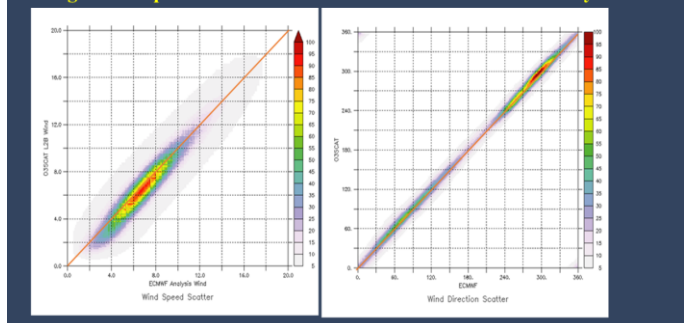
Comparison with HY-2D Scatterometer data:



Comparison of EOS-06 Scat wind data with HY-2D Scatterometer derived winds processed by KNMI



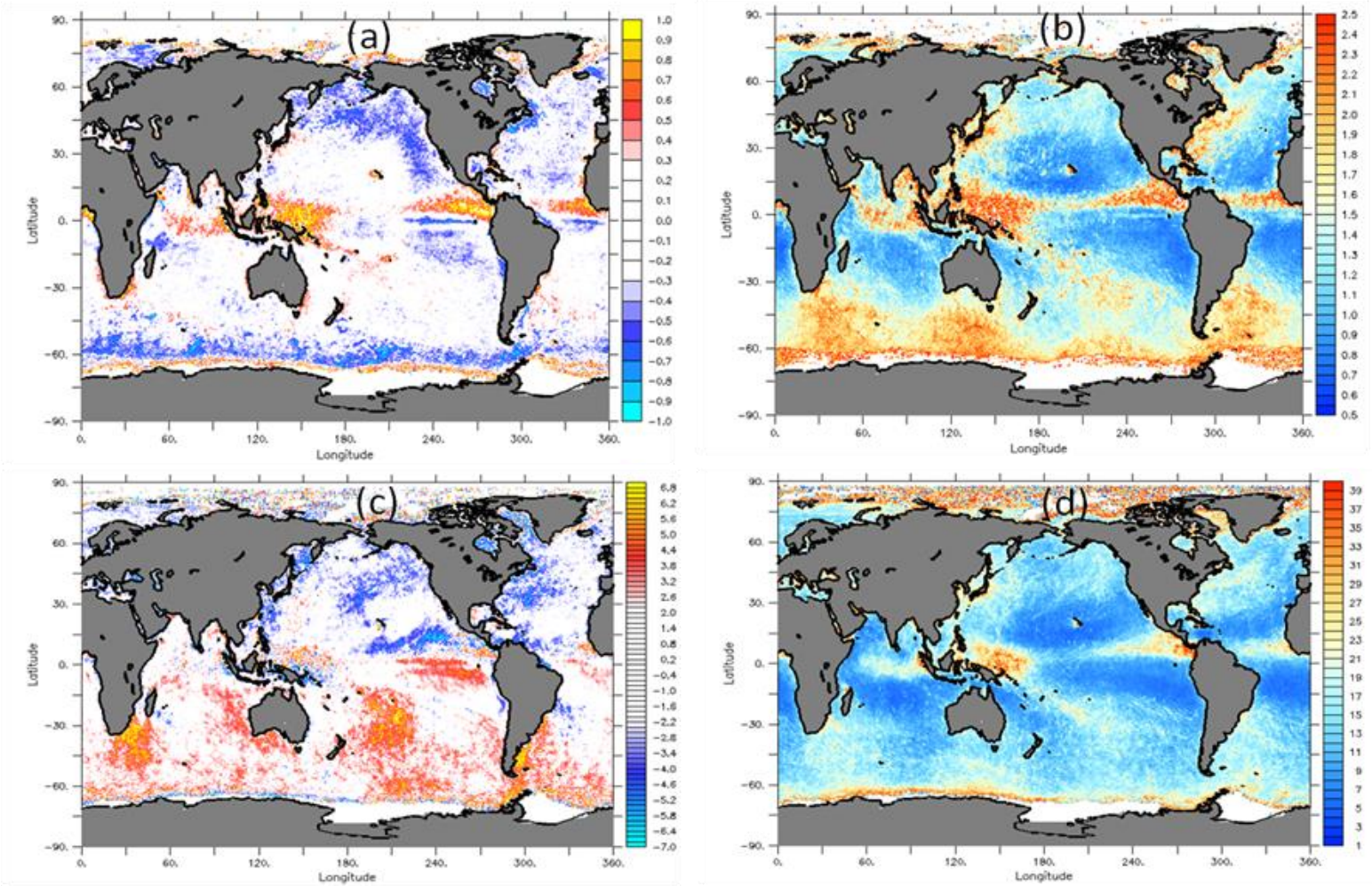
Histogram comparison of EOS-06 Scat winds with ECMWF analysis winds



Density scatter plot of EOS-06 Scat winds with ECMWF analysis winds

Suchandra, et. al., 2025

Spatial variation of mean Bias and RMSE for wind speed and direction between EOS-06 and ECMWF Analysis winds



Wind Speed

Wind Direction

Suchandra, et. al., 2025

Having a larger (1.4m) antenna EOS-06 offers better measurements over low wind conditions and over icy regions
The less swath edges appear in EOS-06 as compared SCATSAT-1 indicate reduced cross-scan bias
Larger heterogeneity is captured by SNR of EOS-06 over low wind regions near equator.
EOS-06 has stable sigma-0 measurements from March2023-Till date over all calibration sites.
The biases like look bias and pass bias over calibration sites remains within +/- 3dB for all beams and is stable till date
Over ocean the sigma-0 remains stable across the swath.

NISAR: Pan-India CR network-status

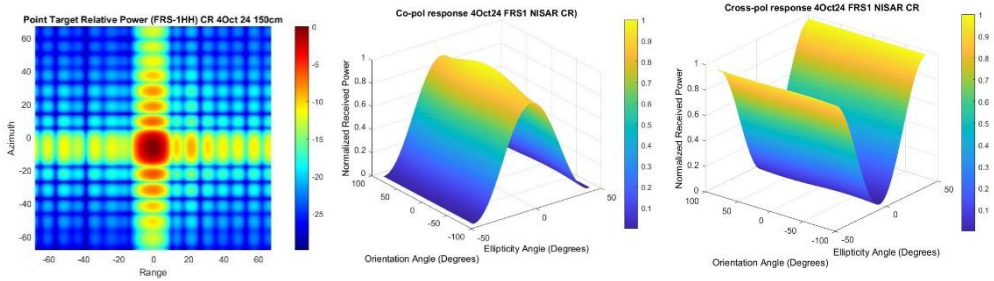
➢SAC In-house designed and developed Corner reflectors deployed at nine locations across India.

➢EOS-04 and NovaSAR data acquisitions over five locations in North India was done during 5 June – 30 June 2025 to monitor the temporal stability of CR response.

Pan-India locations having permanently deployed Corner Reflectors

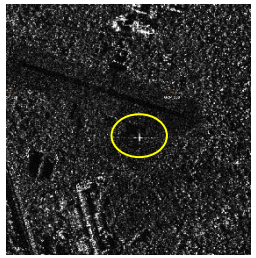
Pol.	RCS estimated (dBsm) (Lab-measured: 41.11 dBsm)	SCR (dB)	Amp. Channel imbalance	Phase imbalance (deg.)
HH	39.90	45.25	0.94	3.49
VV	39.52	42.69		

Estimated calibration parameters for IITK CR (EOS-04 FRS-1 FP 4 Oct 2024)



Date of pass (EOS-04 FRS-1)	Site	Peak power (dB)		Diff. between estimated and lab-measured RCS	
		HH	VV	HH	VV
4 October 2024	IIT Kanpur	93.3	92.8	1.2	1.58
5 February 2023	Bopal, Ahmedabad	92.6	92.1	1.21	1.62

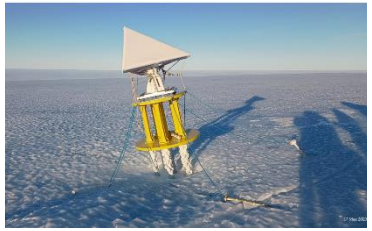
Temporal stability analysis of CR performance



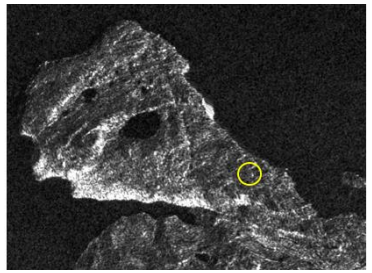
- Peak power of the CR was found to be almost same for both the polarizations as well as the peak power observed in the EOS-04 FRS-1 data acquired almost one and a half years back, over another site (Bopal, Ahmedabad) on 5 Feb 2023.
- This proves the consistency in the performance of the reflector

Antarctica passive targets maintenance and reorientation as per NISAR

- Out of five CRs installed in Antarctica, three were reoriented for NISAR by 44th Indian Scientific Expedition team from SAC during Jan-April 2025.
- Maintenance and DGPS survey of four CRs was carried out. Reflector located at far-range could not be surveyed due to logistics constraints.

	CR Maitri (NISAR)	Icesheet Maitri (NISAR)	Icesheet Maitri (NISAR)	Bharati (EOS-04)
Status of the CR before maintenance				
Status of the CR after maintenance (2025)				

Bharati CR response in 5 March 2025 EOS-04 FRS image



Shweta, et. al., 2021

TRISHNA: Thermal Infra-Red Imaging Satellite for High-resolution Natural Resource Assessment

TRISHNA: Joint project by ISRO and CNES

Primary Objective: Monitoring of the energy and water budgets

Secondary Objective: Assessment of urban heat islands, detection of thermal anomalies, monitoring of snow-melt runoff and glacier dynamics.

Brief mission details

- **Orbit:** Sun-Synchronous
- **Altitude:** 761 km
- **Local time:** 12:30 hrs ± 05 min
- **Swath:** 1030km
- **IGFOV:** 57m (land portion + 100km from coast)
- 1000m (Open ocean)
- **Payloads:**
- Optical (VSWIR) by ISRO**:** Seven bands at 485nm, 555nm, 670nm, 860nm, 910nm, 1380nm and 1610nm.
- Thermal by CNES: Four bands at 8.65µm, 9µm, 10.6µm and 11.6µm.
- **Mission life:** 5 Years

Level 1 data products

Orthorectified TOA reflectance, radiance, BT, coarse cloud mask

Level 2A products

(Radiative Variables)

Atm. Variables (AOD, water vapour)

Albedo

Surface reflectance

Surface temperature

Surface Emissivity

(including Scene classification)

Level 2B products

(Biophysical Variables)

Leaf area index, Net radiation, Water stress index, Evapotranspiration, Vegetation stress

Level 3 Products

Daily analysis of biophysical variables,

Continuous all-sky

Evapotranspiration

Joint Cal/Val plans are underway

- Level-1C (onboard + vicarious methods)
- Level-2A (identified sites)
- Level-2B (identified sites)

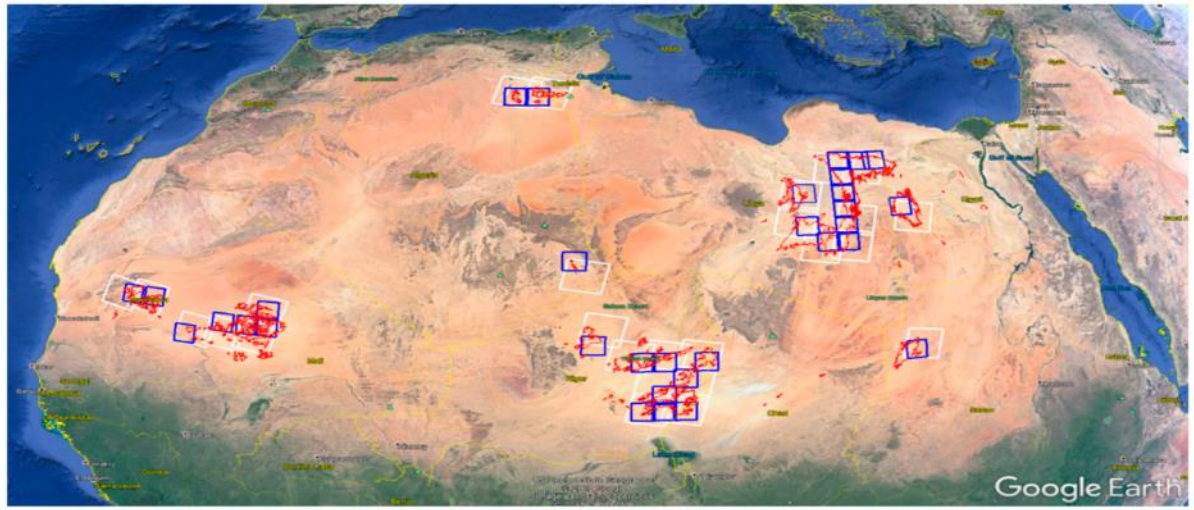
Level-1C (VSWIR)

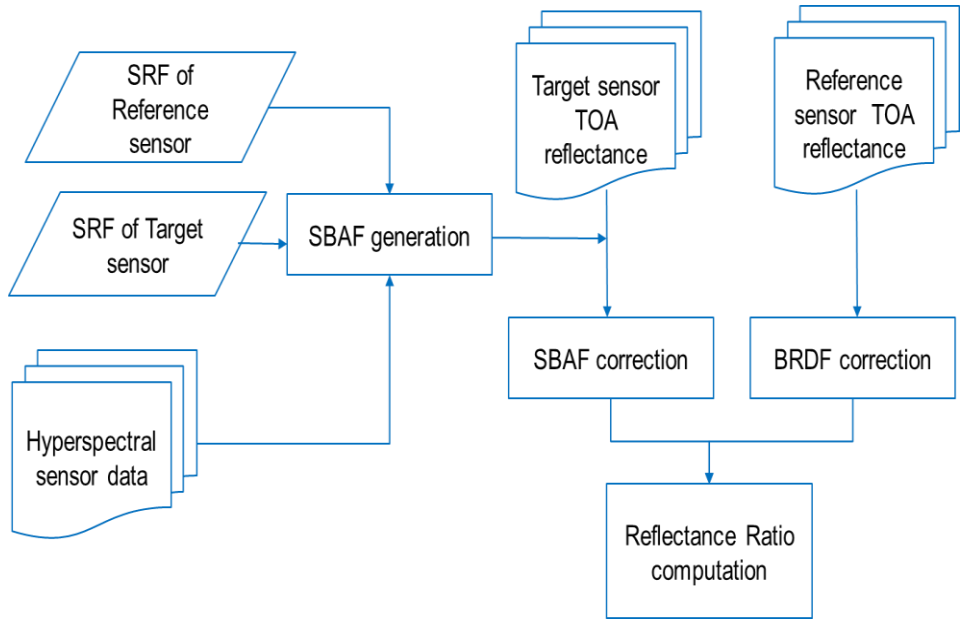
- Vicarious calibration methods like PICS, DCC, moon
- RadCalNet sites
- Cross Calibration
- Ground campaign sites

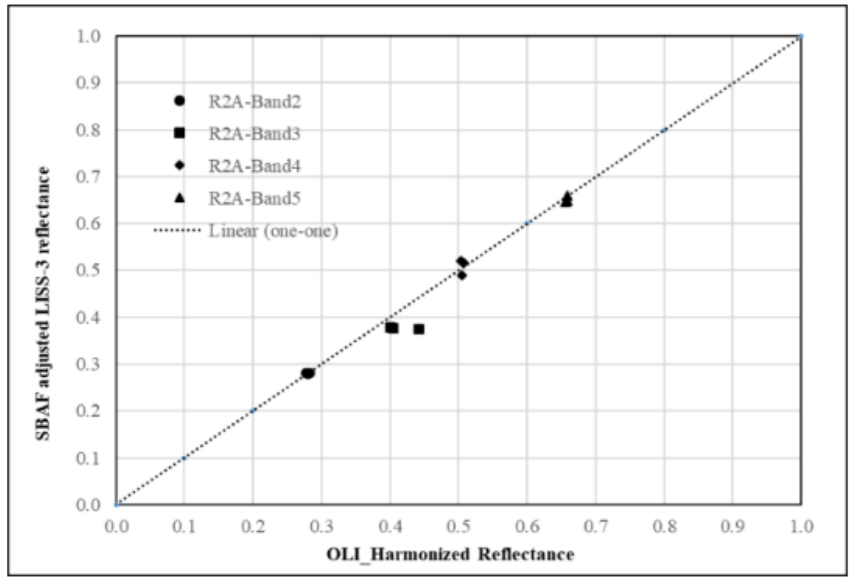
Level-1C (TIR)

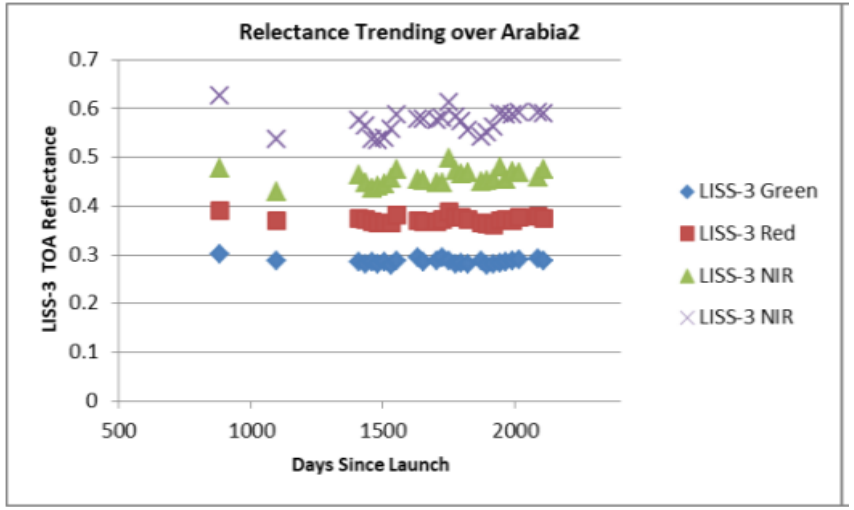
- Onboard blackbody and deep space
- Vicarious calibration methods (Ocean targets, deserts, moon)
- RadCalNet sites
- Cross Calibration

Level-1C (VSWIR): Cross calibration / monitoring

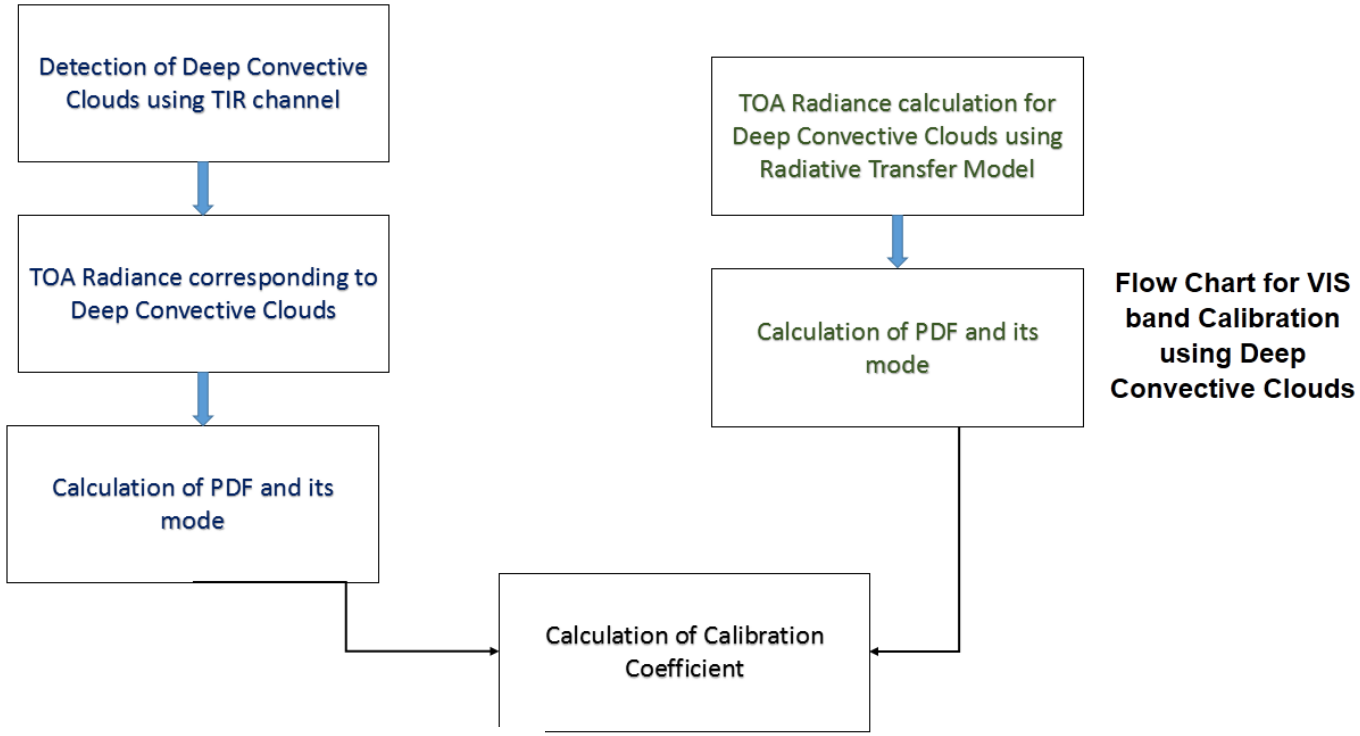




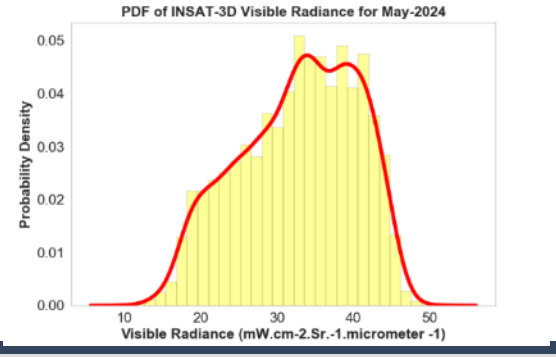




Level-1C (VSWIR): Deep Convective Clouds

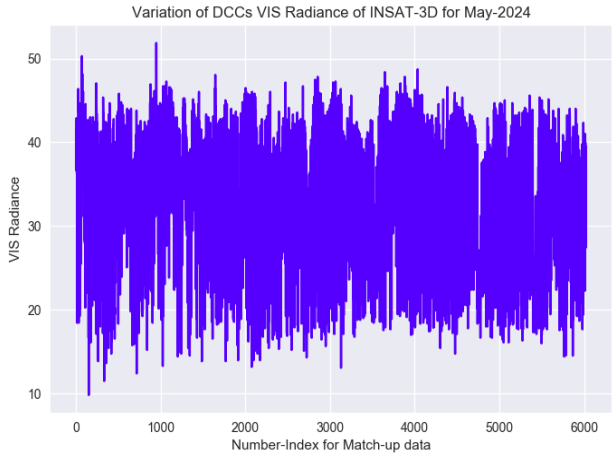


Flow Chart for VIS band Calibration using Deep Convective Clouds

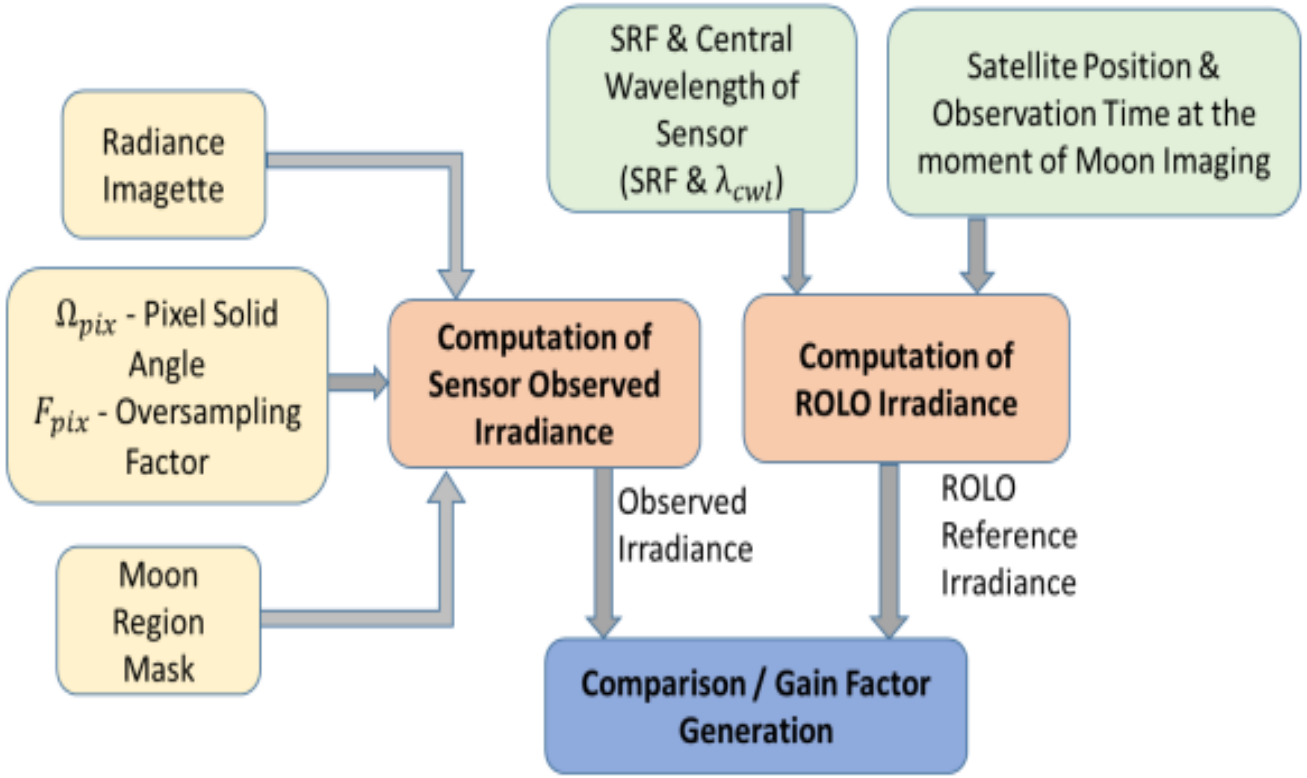


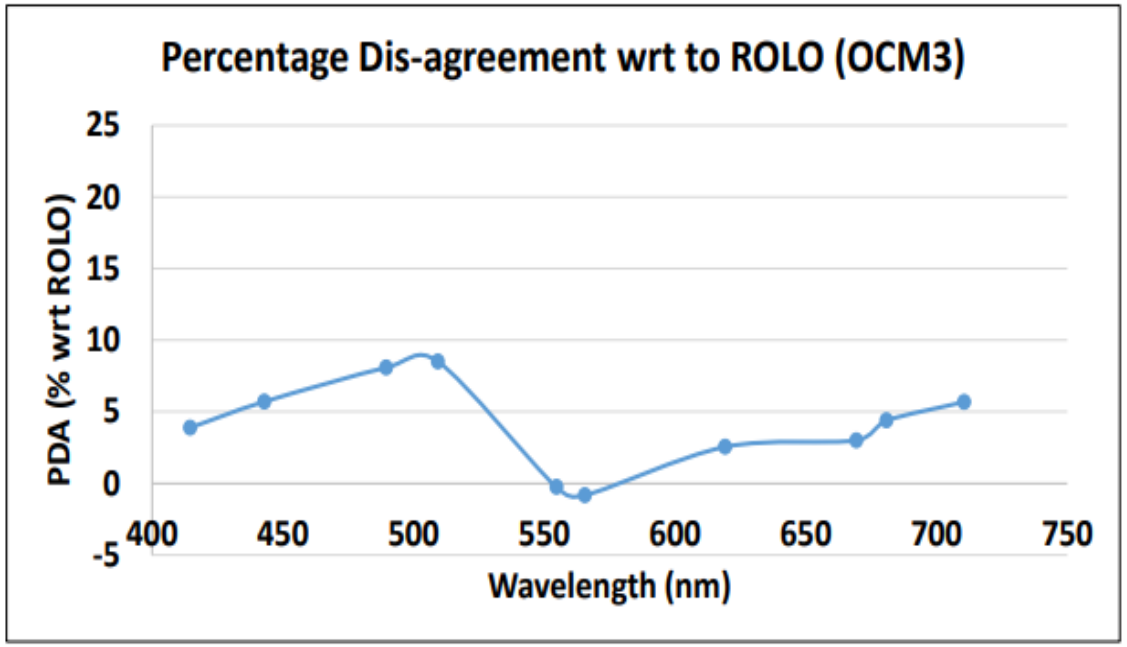
Satellite	Channel	DCCs Calibration Cf
INSAT-3D	Visible	1.13

Results Under review for publication

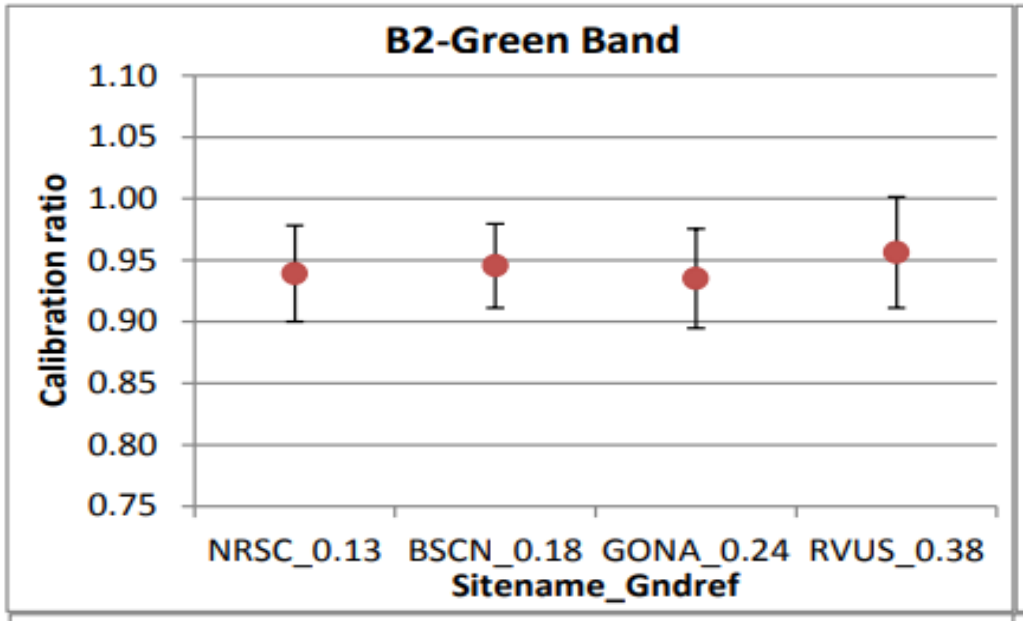


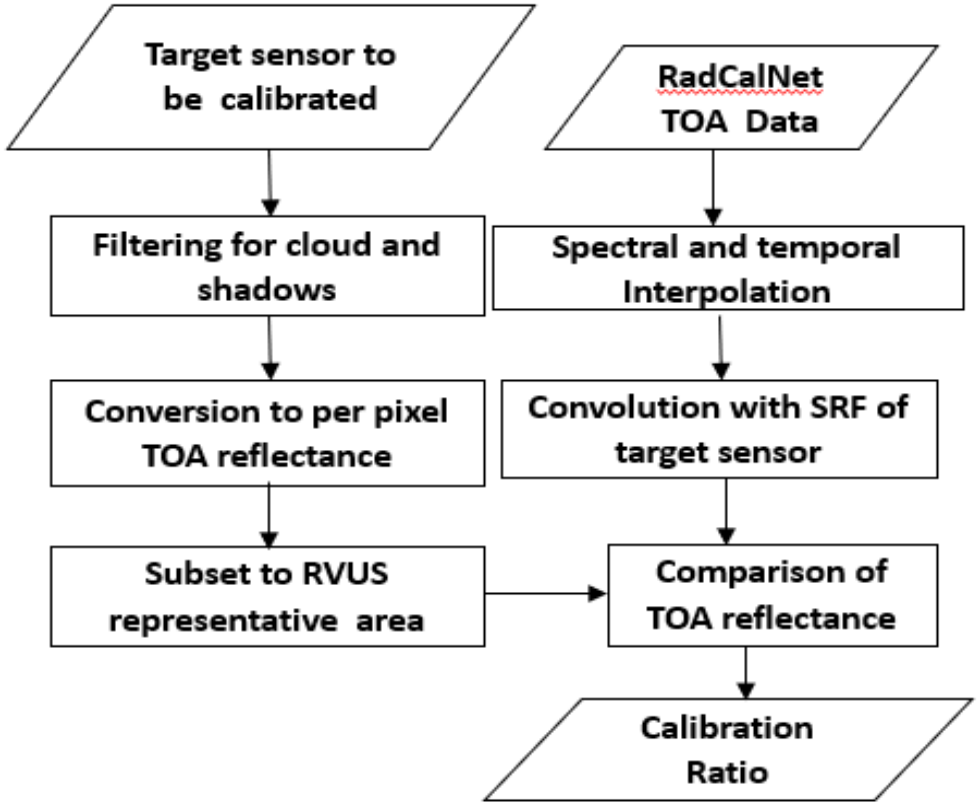
Level-1C (VSWIR): Moon / Lunar imaging



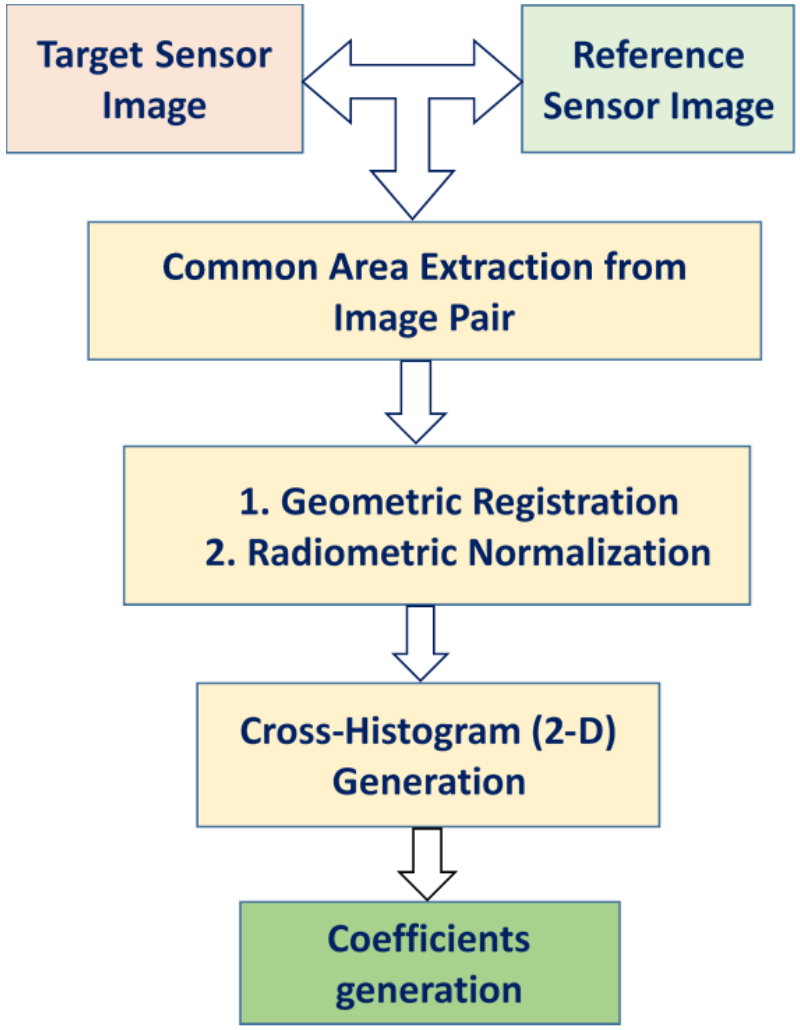


Level-1C (VSWIR): RadCalNet sites





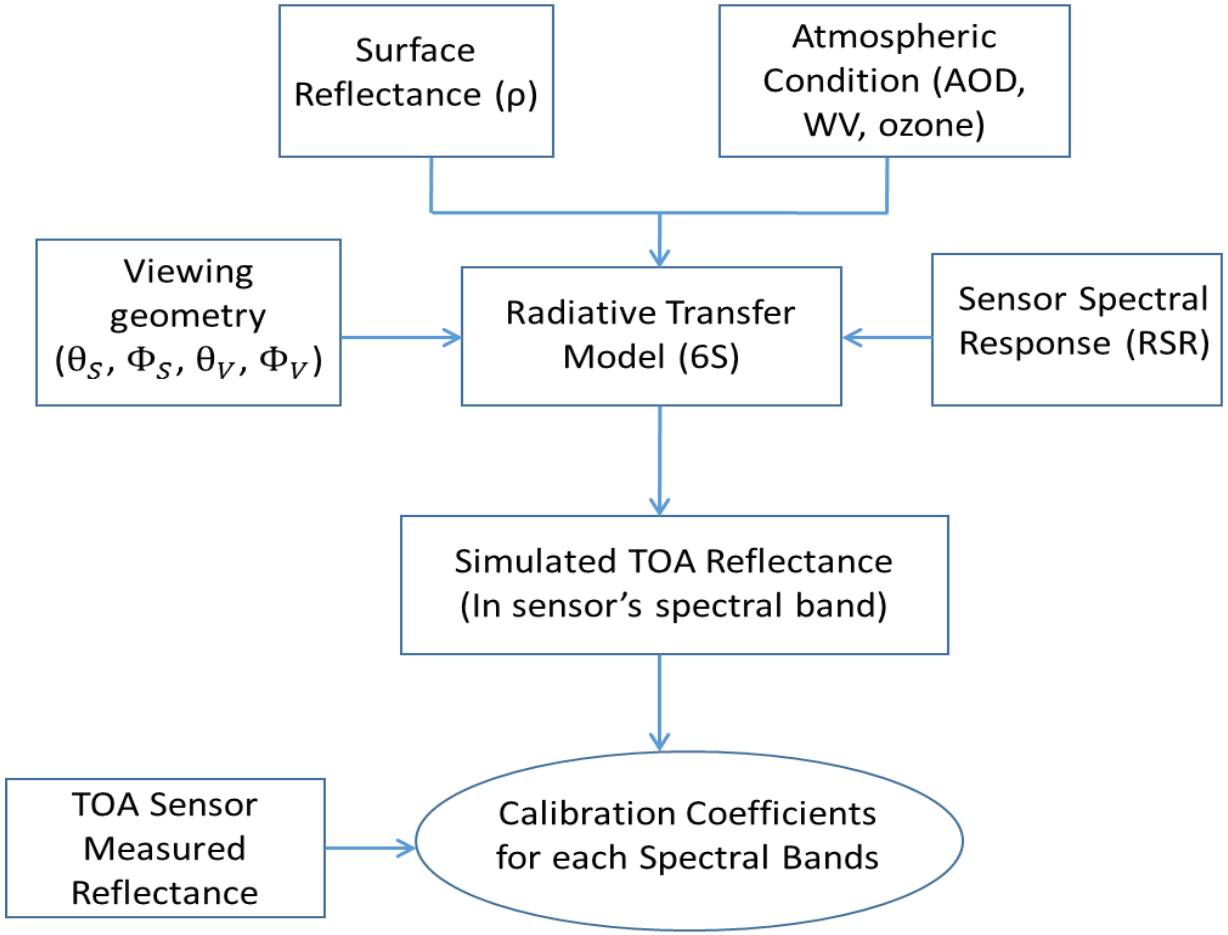
Level-1C (VSWIR): Cross calibration

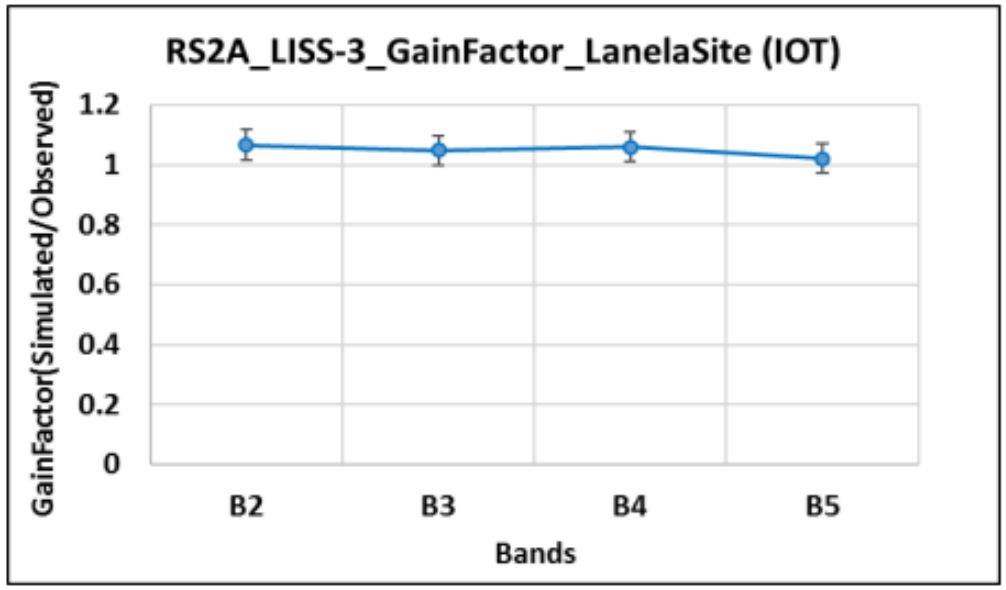


- Inter-sensor calibration will be done over PICS
- Reference sensor with similar spectral bands will be selected
- Matching image pairs will be selected based on synchronous pass with least time gap (~5 to 10 min)
- Spectral band adjustment
- Cross-calibration to generate coefficients

TRISHNA VSWIR						
TRISHNA BANDS (nm)		**Sentinel-3 SLSTR**	**Landsat-8**	**VIIRS**	**PRISMA**	**EnMAP**
VNIR-1 (Blue)	450-520		Band2	M3	400-2505 (239)	420-2450 (224)
VNIR-2 (Green)	520-590	S1	Band3	M4		
VNIR-3 (Red)	640-700	S2	Band4	M5		
VNIR-4 (NIR)	840-880	S3	Band5	M7		
VNIR-5 (WV)	895-925		-			
SWIR-1 (Cirrus)	1365-1395	S4	Band9	M9		
SWIR-2 (SWIR)	1560-1660		Band6	M10		
TRISHNA TIR						
TIR1	8.65 um			M14	IASI (3.62 – 15.5)	CrIS (3.92 – 15.38)
TIR2	9.0 um					
TIR3	10.6 um			M15		
TIR4	11.6 um	S9		M16		

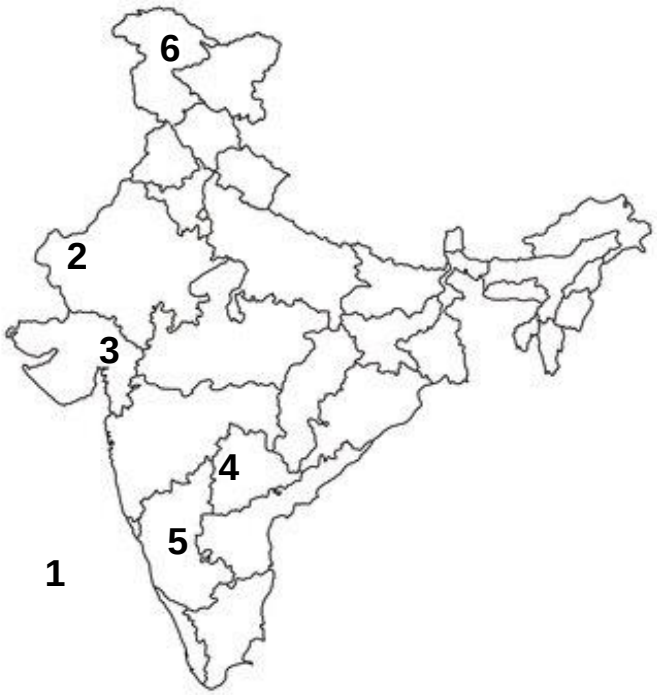
Level-1C (VSWIR) : Ground campaigns



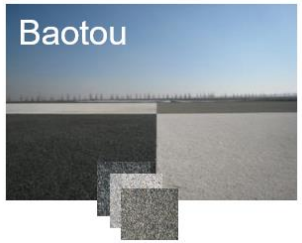


Sites identified for Calibration/Validation

Name	Location	Type	Size(m)	Remarks
Kavaratti	10.590N, 72.260E	Ocean	open	Type 1 waters
Lanela	27.041N, 70.848E	Dry Playa	1200*1000	Spatial homogeneity better 5%
Little Rann of Kutch	23.480N, 71.400E	Dry Playa	6000*6000	Spatial homogeneity better 5%
Shadnagar	17.033N, 78.184E	Red Soil	220*220	Spatial homogeneity better 3%
Challakere	14.387N, 76.723E	Red Soil	600*600	To be done
Gulmarg	34.060N, 74.380E	Snow	240*650	Spatial homogeneity better 3%



Level-2A Cal/Val



Available parameters for validation

- Surface reflectance
- Surface Temperature
- Aerosol Optical Depth
- Water Vapour

- ✓ Automatic daily measurements from 9:00hrs to 15:00hrs at 30min intervals.
- ✓ VSWIR measurements released since 2018.
- ✓ Three sites spectral measurements cover upto SWIR region.
- ✓ Lacrau and Gobabeb provide surface temperature measurements.

Site based area selection>>Time matchup>>Spectral interpolation>>Spectral integration in VSWIR bands

ISRO’s P-band Airborne SAR Cal-Val Activity

P-band Cal-Val Activity:

- Establishing unique SAR calibration and validation methodology for accessing foliage penetration for strategic application .
- Characterization of the foliage penetration with different types of corner reflectors / vehicles deployed under in and around IMGEOS campus.
- Corner Reflectors are deployed in IMGEOS Cal-Val Site to carryout Radiometric and Geometric evaluation of P-Band SAR data.

Site Requirements: The location for deploying Corner Reflectors vehicles are identified based on following criteria:

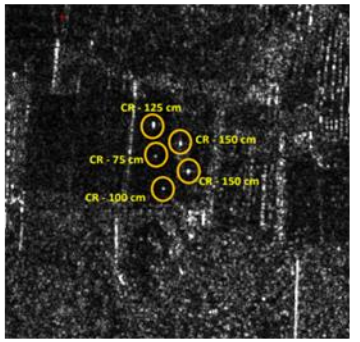
- ✓ Signal penetration direction through canopy based on incidence angle and look direction
- ✓ Void of any built-up areas nearby
- ✓ Ease of accessibility into the foliage for the vehicle.

Cal-Val Activity Period : June – August 2024 (in 3 campaigns) as a part of ISRO’s Indigenously developed Airborne P band Sensor Calibration & Validation

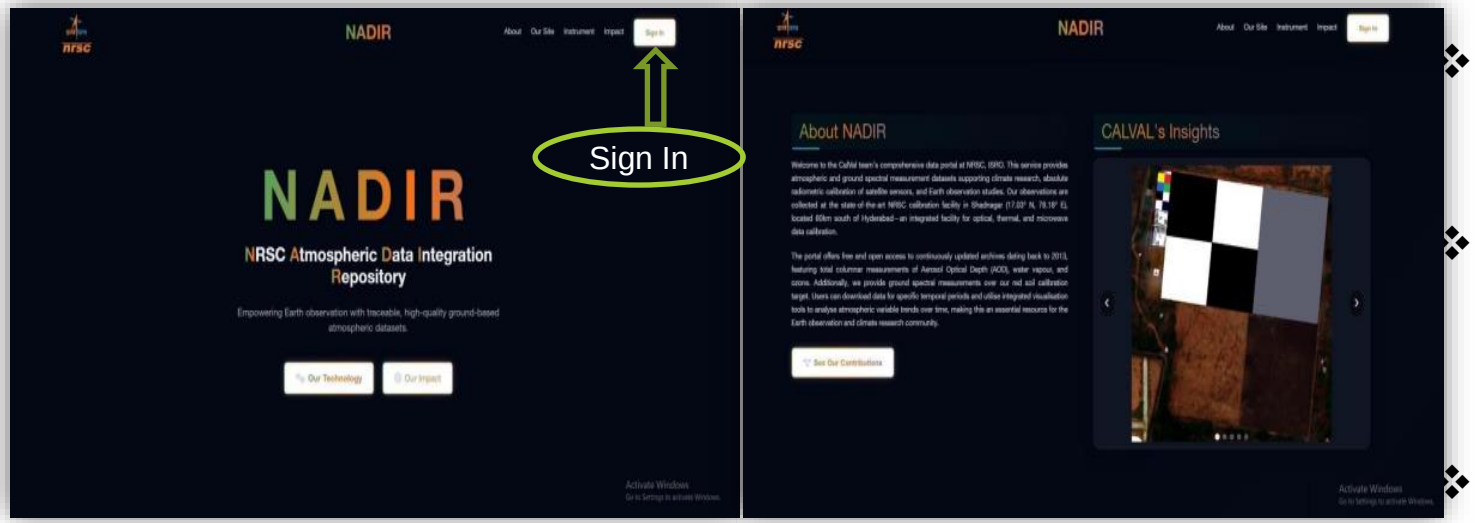
Teams involved:

- Space Application Centre (SAC)/ISRO
- National Remote Sensing Centre (NRSC)/ISRO
- Advanced Data Processing Research Centre (ADRIN)

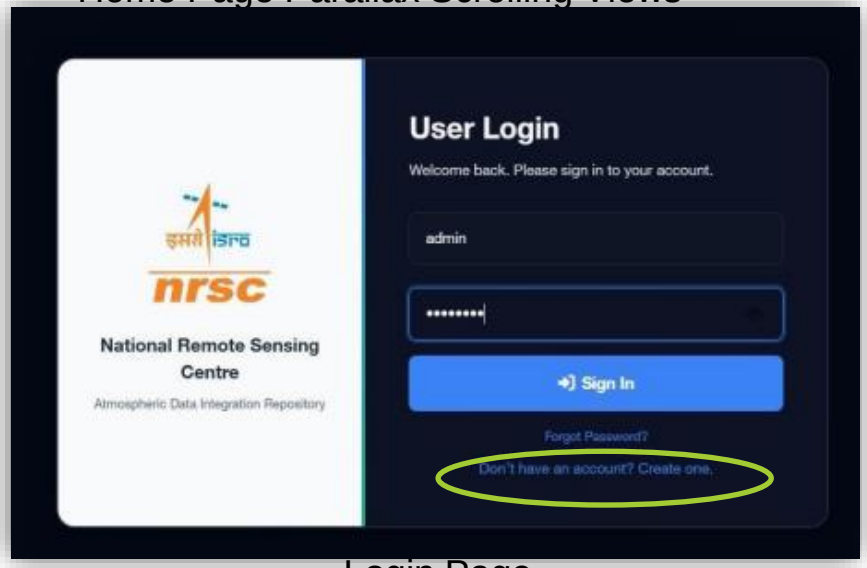
Way Forward: Further refinement in calibration and validation strategy with collaborations between stake holders/Researchers can be brought towards Airborne and space-borne P-band SAR data products for Global and Regional Forest Biomass estimates.



Atmospheric Data Dissemination Portal- NADIR



Home Page Parallax Scrolling Views



Login Page

- A web-based platform that provides access to *insitu* measurements collected from NRSC's calibration site at Shadnagar.
- Atmospheric Parameters
  - ✓ Aerosol Optical Depth (AOD)
  - ✓ Total Column Ozone
  - ✓ Total Column Precipitable Water Vapor
- Instruments
  - ✓ CIMEL (CE318) sunphotometer
  - ✓ Microtops II sunphotmeter
  - ✓ Microtops II ozonometer
- Temporal Frequency
  - ✓ 15 minutes interval
- Key Features
  - ✓ **Interactive trend plots** for quick visualization
  - ✓ **Filtered data** downloads (*.csv* format) by date, parameter, and site
  - ✓ Access to validated and quality-screened datasets
  - ✓ User-friendly interface with **data availability indicators**

Relevance to Cal-Val and Atmospheric Research

Home Page Parallax Scrolling Views

Data Download Views

For Calibration and Validation:

- ✓ Provides traceable ground-based measurements essential for satellite sensor calibration
- ✓ Supports validation efforts for Indian Remote Sensing (IRS) missions and other EO programs

For Scientific Research:

- ✓ Enables climate trend analysis, aerosol studies, and atmospheric correction
- ✓ Facilitates validation of satellite retrievals for improved model performance
- ✓ Complements global networks such as RadCalNet

Importance to User Community

- ✓ Offers consistent, high-quality datasets for long-term scientific use
- ✓ Makes curated atmospheric measurements easily accessible to the research community
- ✓ Strengthens global initiatives in satellite cal-val activities and environmental monitoring

CAL-VAL TEAMS:

National Remote Sensing Center(NRSC), Hyderabad, ISRO, INDIA

Space Application Center (SAC), Ahmedabad, ISRO, INDIA

Thank you….