NRSC, ISRO Cal-Val activities

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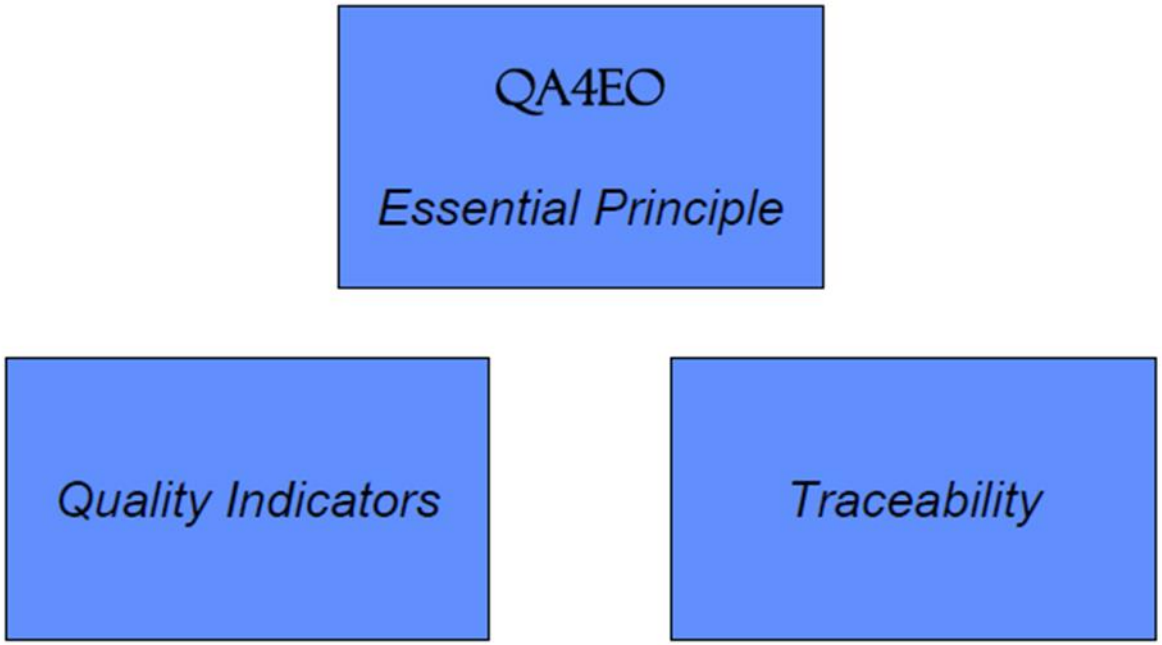
Over view

- In-House Cal-Val facility
- Campaign site for coarse resolution data: Rajasthan Desert site.
- Campaign site for coarse resolution data: River sand based In Telangana state.
- Global satellites covered by in-house site
- Global satellite covered by Campaign sites
- High resolution customized targets
- Microwave calibration facility
- Thermal Data calibration feasibility
- BRDF characterization of Optical targets
- International cooperation

Post launch EO data products
Quality Assessment & Data Calibration



Established by

Data Quality Evaluation System

Established by

Calibration/Validation System

Calibration Parameters

MX/Hyperspectral Optical Data:

- ❑ Radiometric Accuracy
- ❑ Radiometric response stability on orbit phase
- ❑ Radiometric Calibration Coefficients

High Resolution Data:

- ❑ MTF and absolute Geometric accuracy
- ❑ Resolvable Pixel size

Microwave Data:

- ❑ Geometric accuracy
- ❑ Radiometric Calibration Parameters:
  - PSLR
  - ISLR
  - Calibration constant
  - IRW

Optical Data Calibration

Instrumented IMGEOS Cal-Val Facility and ongoing Calibration activities

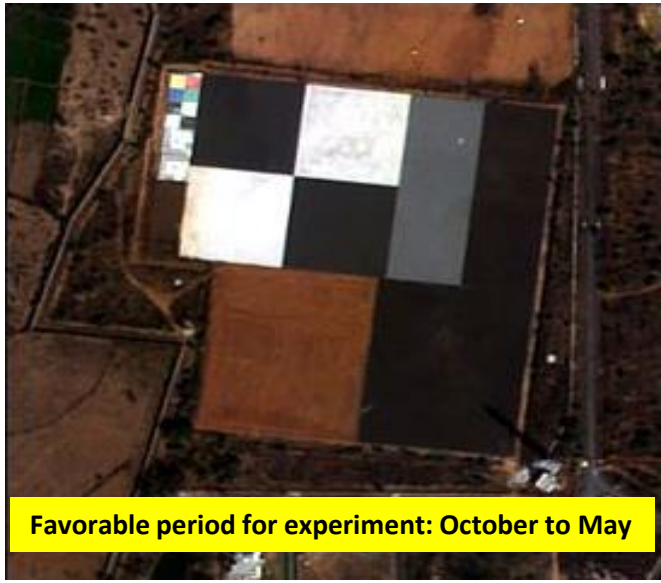
Post launch - Periodic evaluation of radiometric and geometric performance of the Space-borne Optical sensors for the purpose of traceability.

IMGEOS CalVal Site

Operationalised Jan 2016

Targets: Optical

Five Natural targets with the reflectance ranging from 8% to 70% in the VNIR .



Favorable period for experiment: October to May

Calibration:IRS Sensors

✓ Geometric Calibration of High resolution Data products, Carto2, Carto2S

✓ Absolute Radiometric Calibration of IRS (Multi spectral and Hyperspectral) optical Data Products: (360m to 1.6m resolution)

✓ Radiometric Characterization (MTF/SWRestimation) high resolution data 5m,3m,2m,0.8m and 0.6m using Edge targets & Mirror targets and SWR targets

Calibration : Contemporary Global Sensors

✓ Radiometric characterization of AVIRIS-NG and Planet labs

✓ Landsat8/Landsat7 and Sentinel2A calibration used for IRS sensors cross calibration

Global Interactions: NASA,DLR and KARI

-LTWG Team Visited and Landsat8/7 calibration results were demonstrated

- Facility is demonstrated to DLR Team Jan 2018 (ISRO-DLR Meet) & Kompsat Team

Rajasthan (India) CALVAL Experiments

Optical Target's Spectral Response

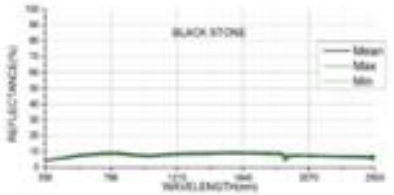
Shadnagar site as viewed by C2S series sensor (NCC).

Site as viewed from bore sight tower

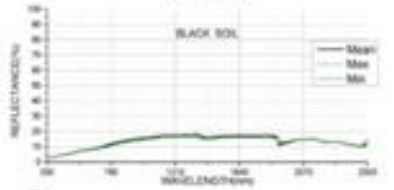
Instruments

Row1: Automatic Weather Station, Sun-Photometer,
Row2: MICROTOPS Ozone monitor, Spectro-radiometer, Handheld GPS.

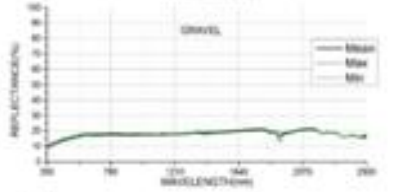
Five natural targets



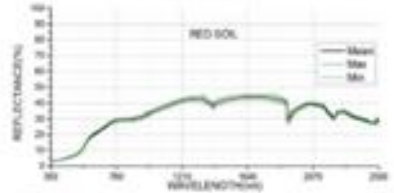
Black Stone



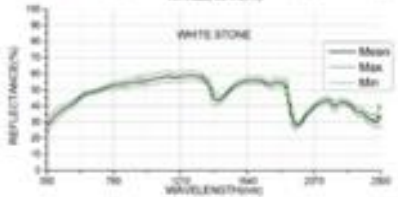
Black Soil



Gravel



Red Soil

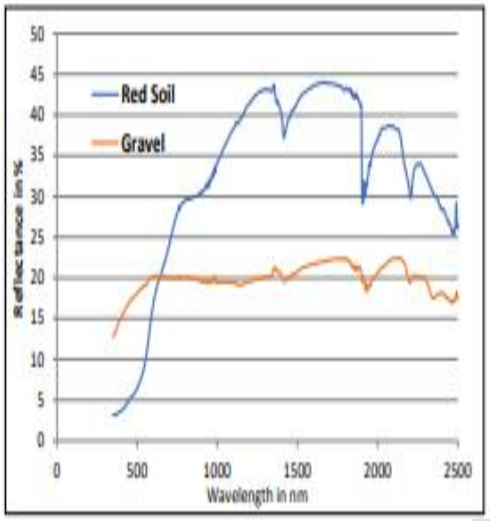


White Stone

Resourcesat-2/-2A LISS-4 Absolute Calibration

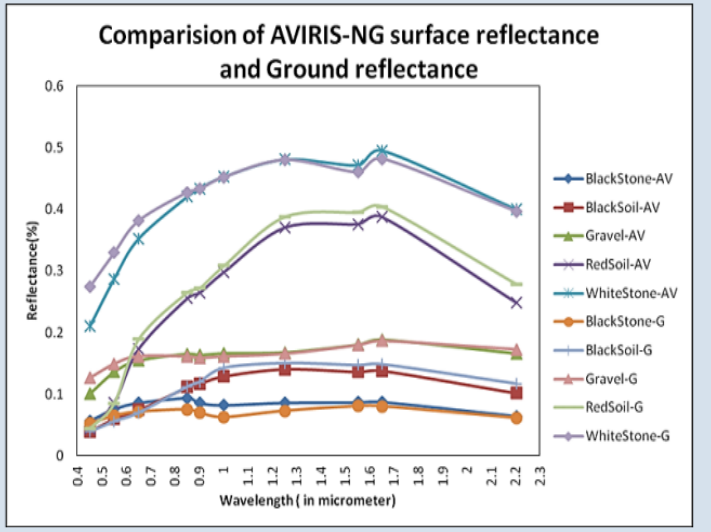
Sites Used

ISRO Calibration Site @Shadnagar (Red Soil and Gravel Target)

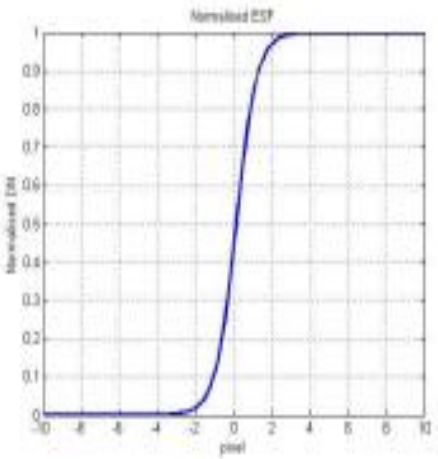


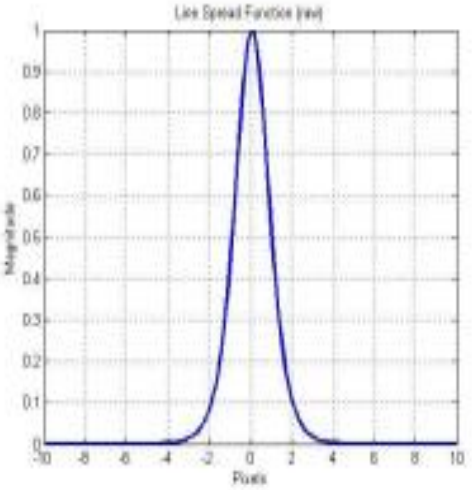
Site Characteristic

Parameter	Gravel Target	Red Soil Target
Area	140 x 100 m	125 x 105 m
Spatial Uniformity	better then 3%	better then 3%
Elevation	635 m	635 m
No. of LISS-4 pixel used	~200	~200

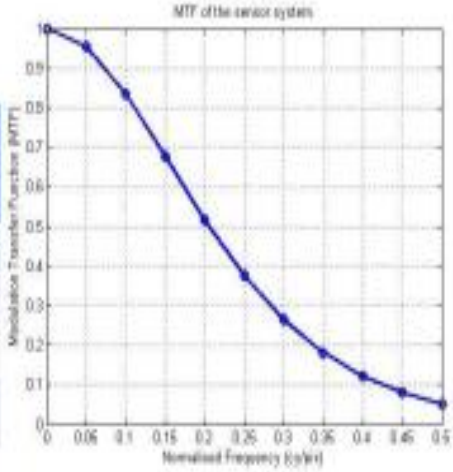


Resourcesat-2/-2A LISS-4 MTF





Parameter	Summary for three bands
RER	0.35-0.42
LSF (pix)	1.8-3.0
MTF @ny (5m GSD)	2-5% and ~10% at 5.8m

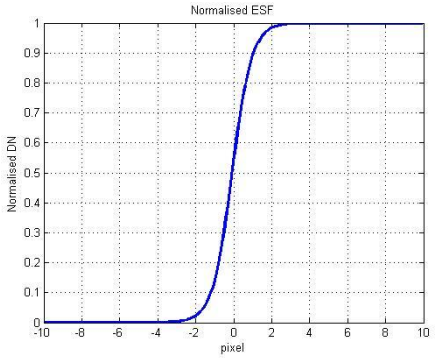


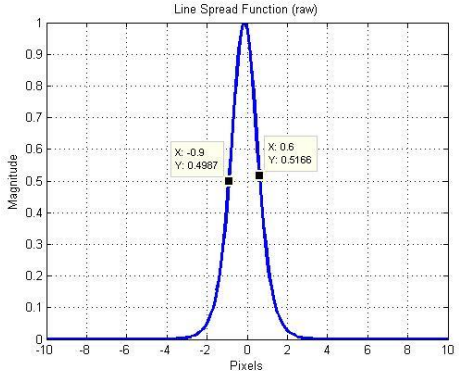
In-house MTF Edge Target High for resolution sensors

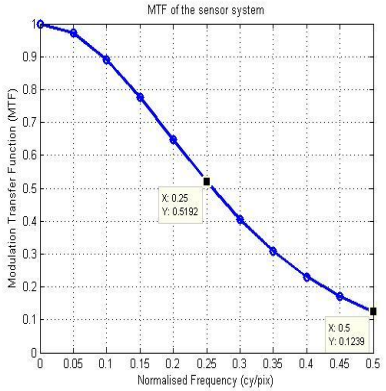
- 70mx70m White and black contrast 6deg oriented edge facilitated high resolution data MTF estimation. 6m or better.
- Based on this target Resourcesat-LISS4, Carto-1, Cato-2, Carto-2S, Carto-3, EROS, World View2, Planet Labs , Digital Globe, Triple sat, AVIRIS(airborne) and Pleiades MTF is estimated.
- This site is well maintained.
- The artificial targets are created with naturally available stones.

IRS: Cartosat, High resolution, PAN

Pleiades: PAN

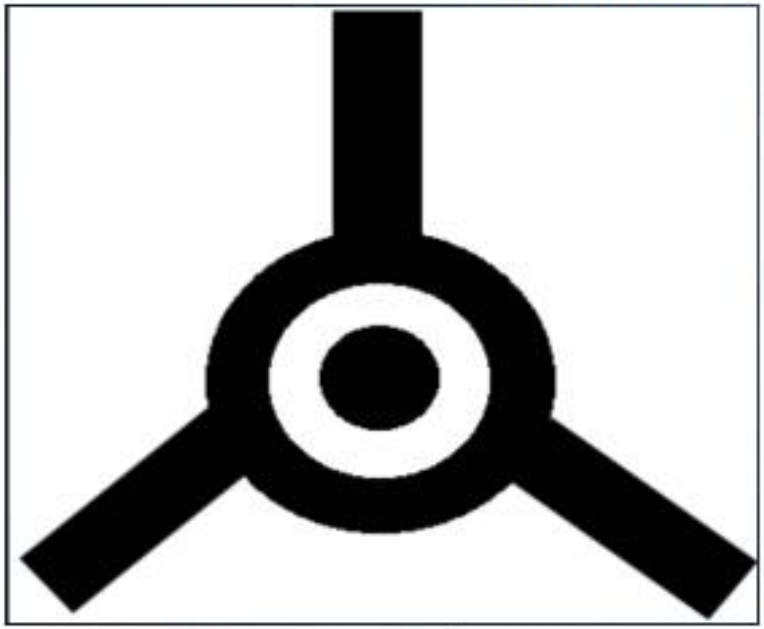


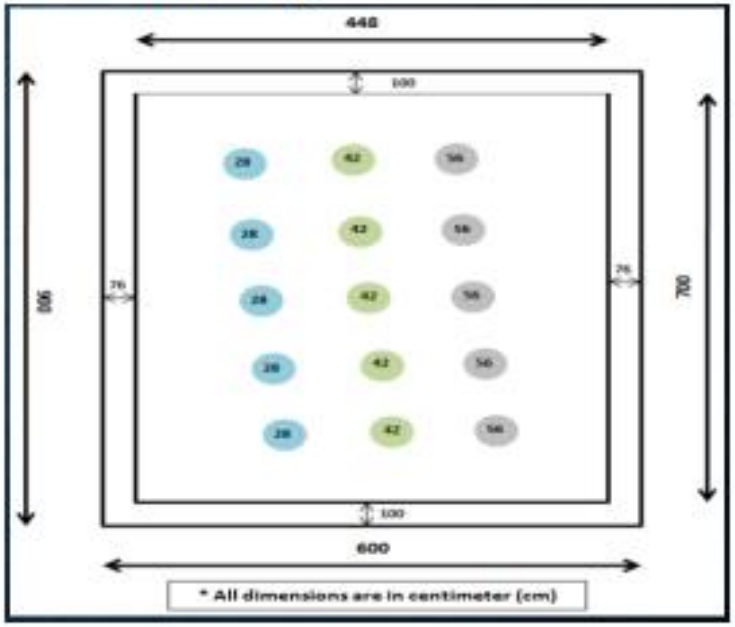


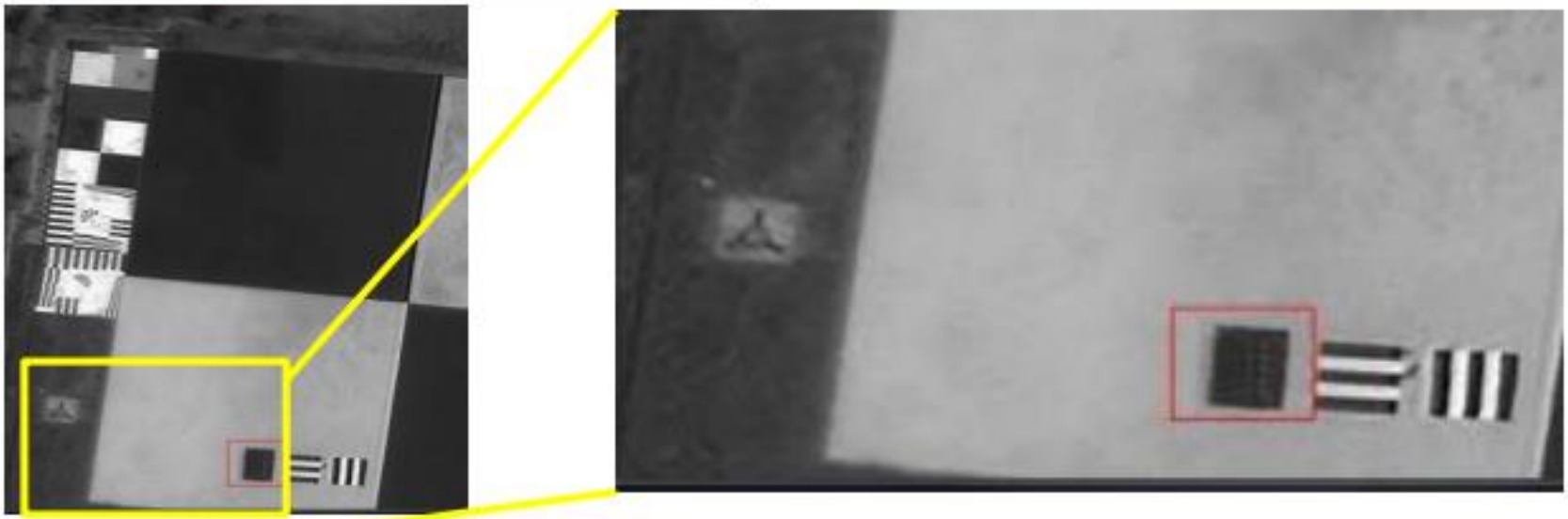


Development of targets & ground instrumentation

Resolution based GCP and Circular target







Bar Targets

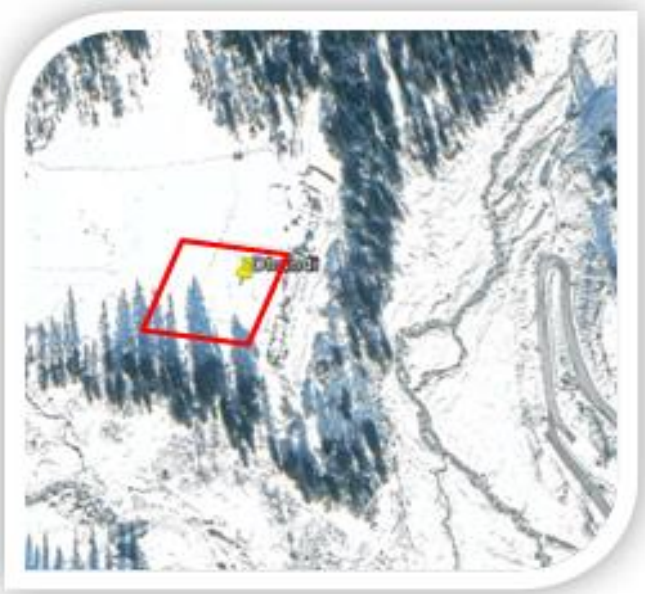
Resourcesat-2 LISS3 Spatial Characterisation

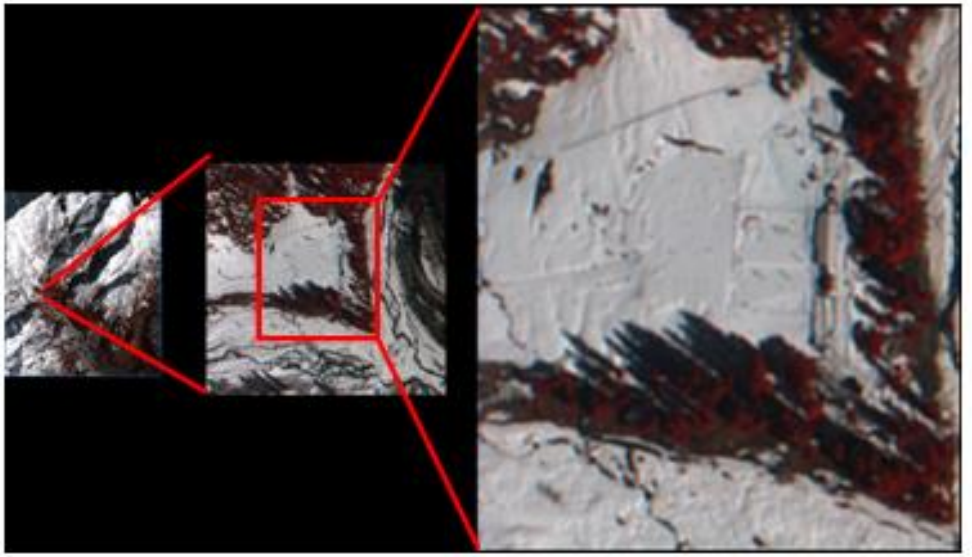
DOP: 08Apr2020
Path-Row: 80-59
Sensor: RS2-L3
Product Type: Geometric Corrected

Target Lat/Lon: 19.69N, 57.70E

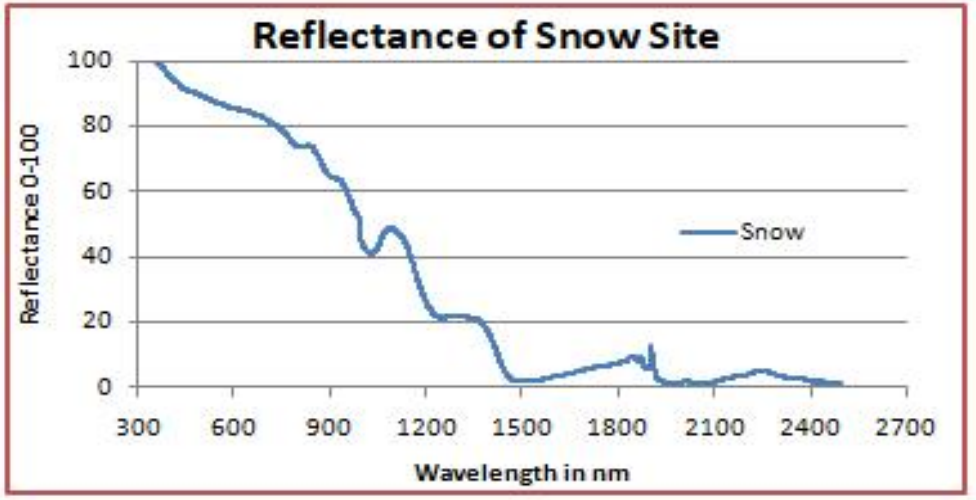
Parameter	Band-2 Green		Band-3 Red		Band-4 NIR		Band-5 SWIR	
---	AL	AX	AL	AX	AL	AX	AL	AX
RER	0.4897	0.5035	0.5056	0.5019	0.4992	0.5508	0.4642	0.5993
LSF (pix)	1.65	1.6	1.6	1.6	1.6	1.45	1.6-1.7	1.2
MTF	9.55	10.49	10.84	10.6	10.22	15.035	7.35	22.62

High resolution High reflectance target Campaign mode





Experimental site imaged by C2E-MX on 03 March 2020



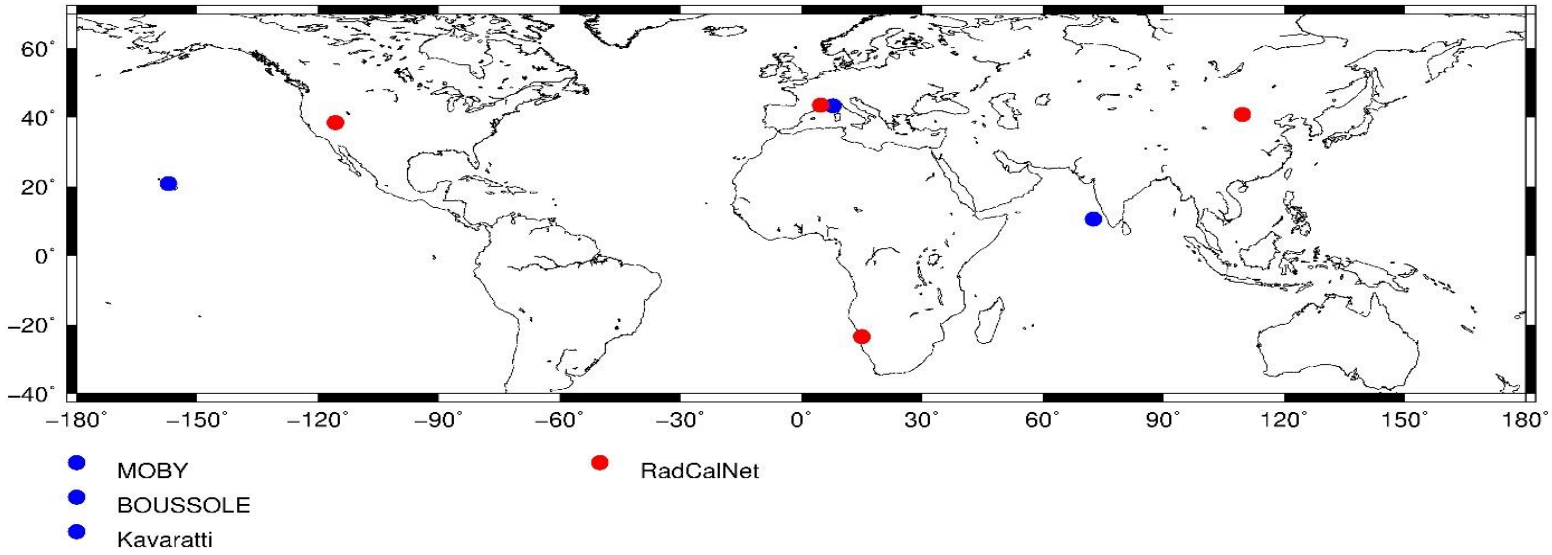
Identification of Campaign sites

Munchintala, Mahabubnagar District

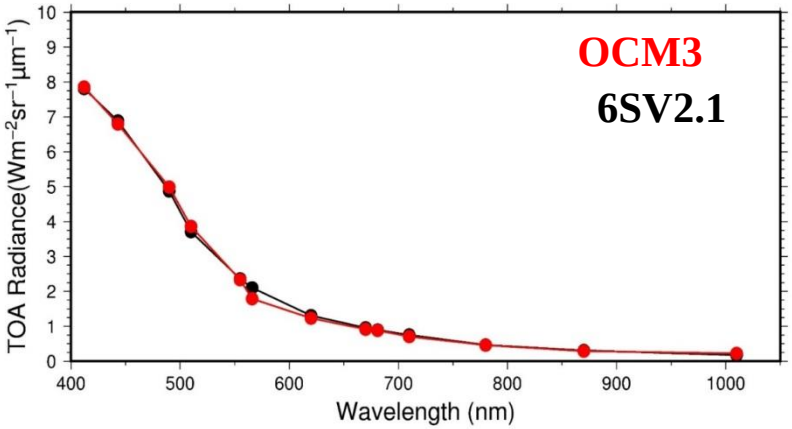
Mandarna , Nizamabad District

Gulmargh, Jammu & Kashmir

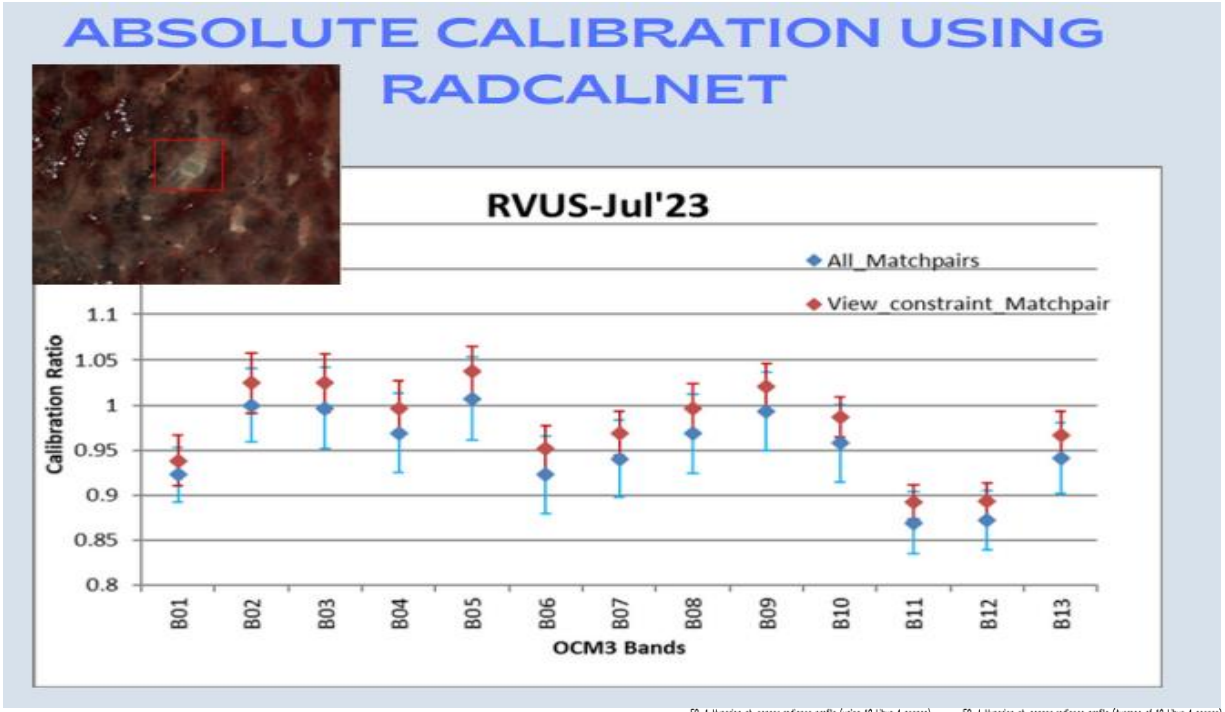
OCM Sensor Data: Vicarious Calibration

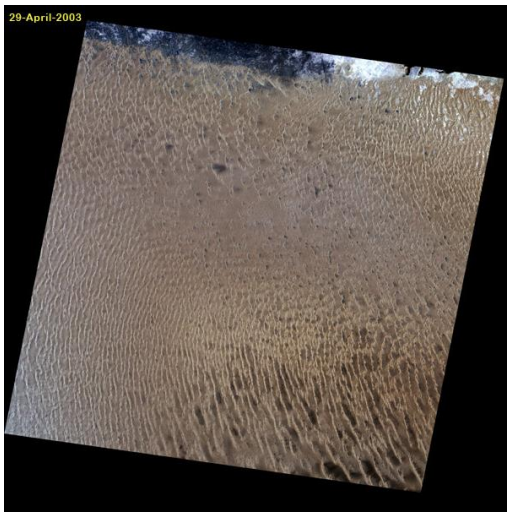


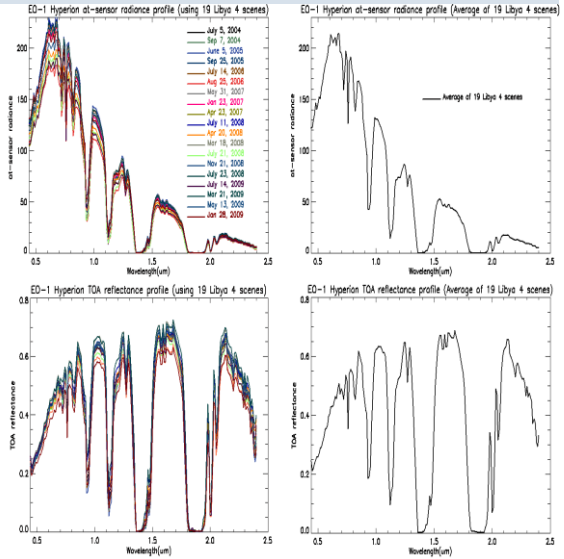
- The MoBY and Kavaratti observations (December 2022 – May 2023) were used to ascertain the OCM3 radiometric performance.
- The first ocean Vcal has been generated using these data sets.
- The observations from Cal-Val cruises, MoBY observations are further used to strengthen the matchups data sets.



Proposed Radiometric stability monitoring target- Libya/Global sites





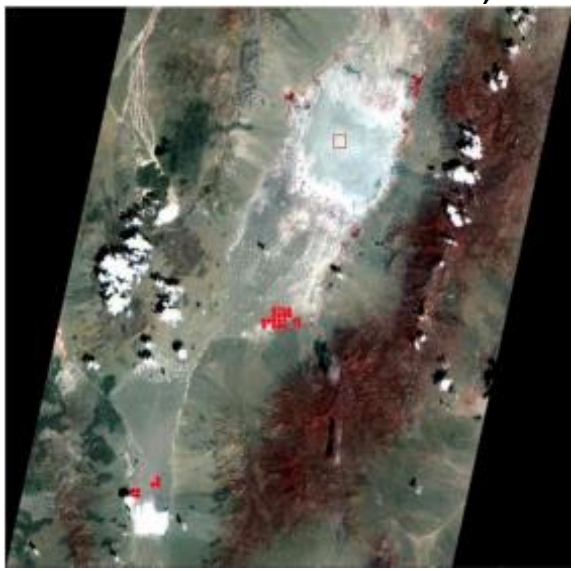


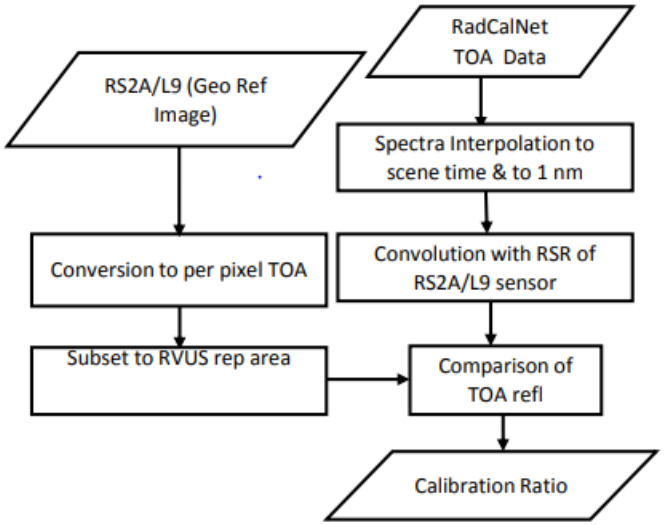
Resourcesat-2A

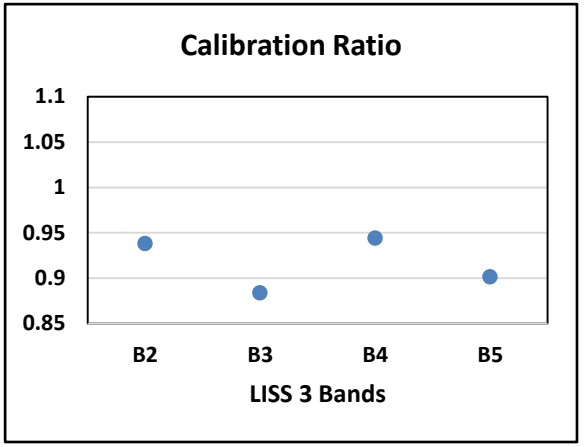
Site: Rail Road Valley Playa, Nevada, USA

ROI: 1km * 1km

Sensors evaluated: LISS-4,

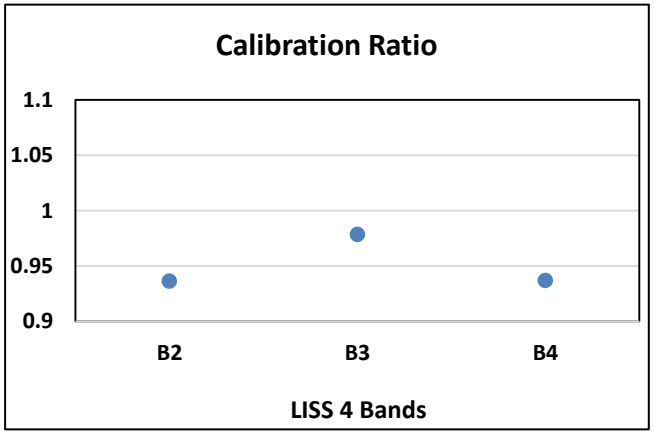


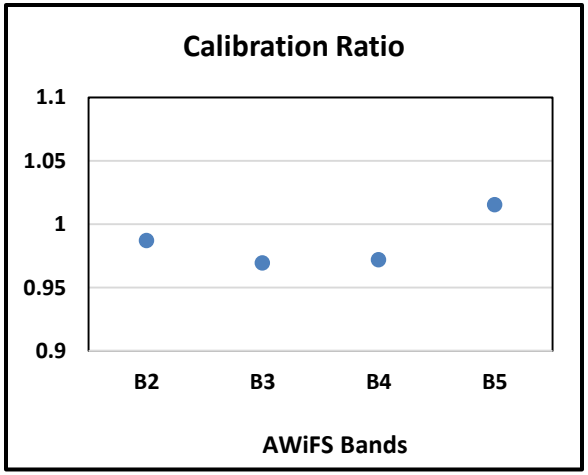




Calibration Ratio

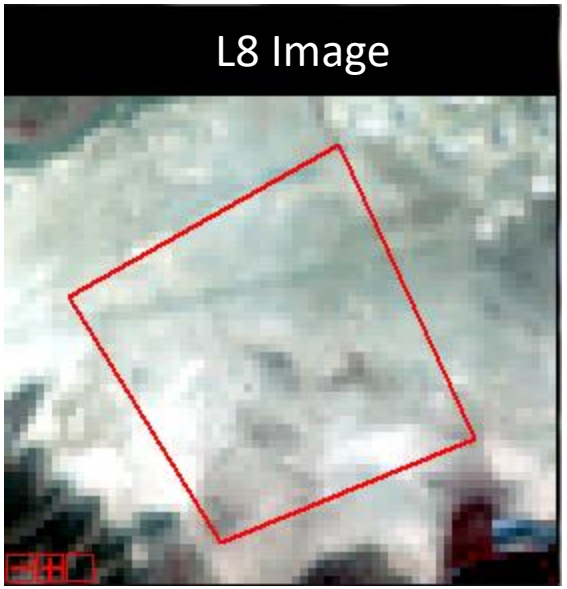
$$Ratio = \frac{\rho_{TOA\_sensor}}{\rho_{TOA\_RadCalNet}}$$

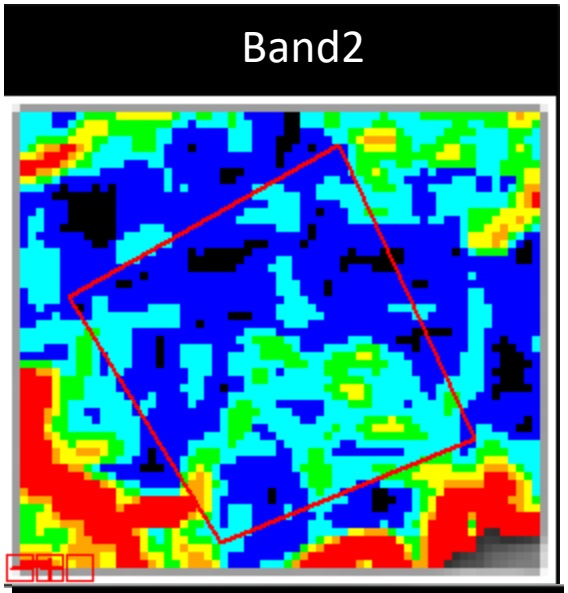


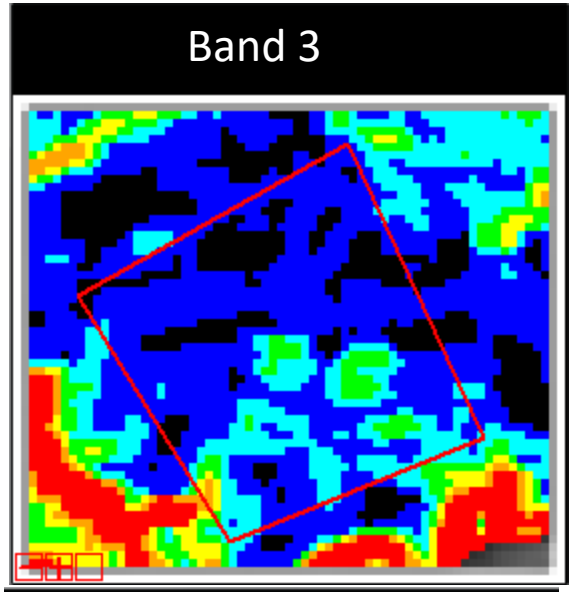


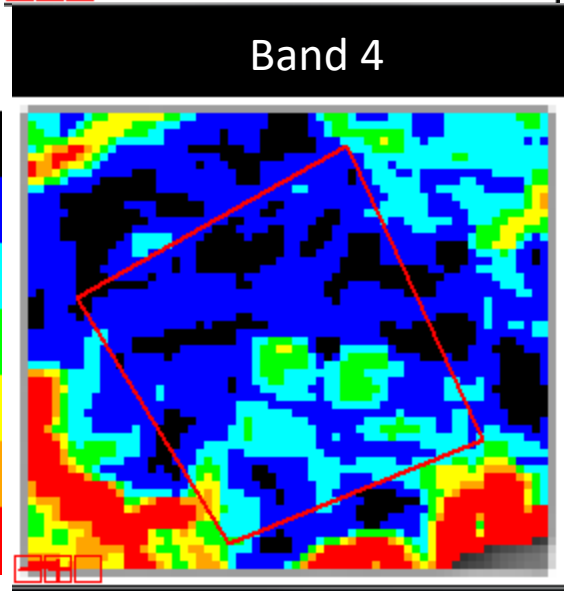
Post launch response is consistent for all 3 payloads

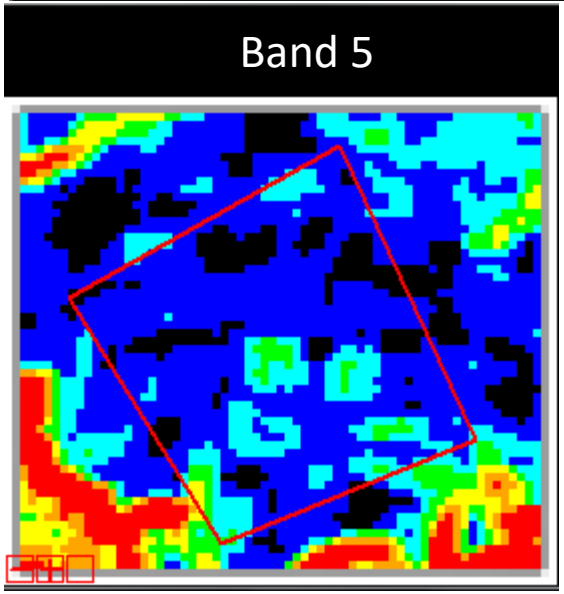
L8 CV Analysis for the Campaign site

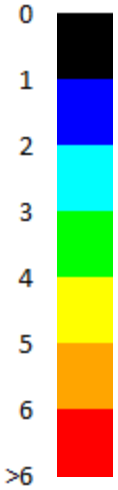










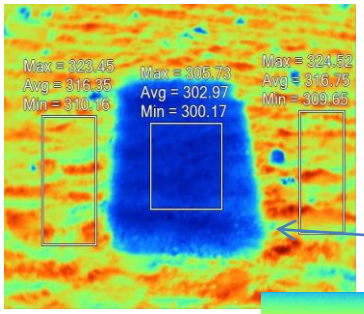


CV better than <4%

High and medium resolution Thermal data calibration HRSAT(LWIR)Microsat(MWIR/LWIR)/ Cartosat 3A/3B/3C(MWIR)

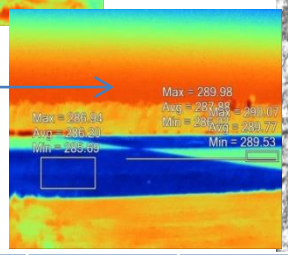
Gradient simulation for high resolution data(6m/4m)

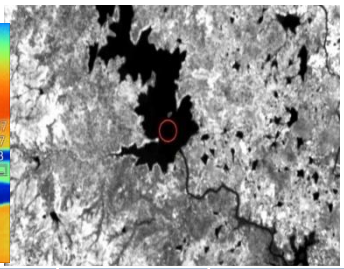
Data Buoy deployment in reservoir lake & thermistors for HRSAT(methodology proved using Landsat8,TIR bands)



23 deg gradient on the same back ground

Natural gradient





RT code: MODETRAN

Handheld NTC thermistor	Seabird CTD sensor, CT37	Drifting buoy NTC thermistor	Handheld thermistor PT100	Fluke TI400	From LANDSAT8 TIR band
297.167	297.164	297.148	297.136	296.7	296.240

Microwave Data Calibration

Parameters:

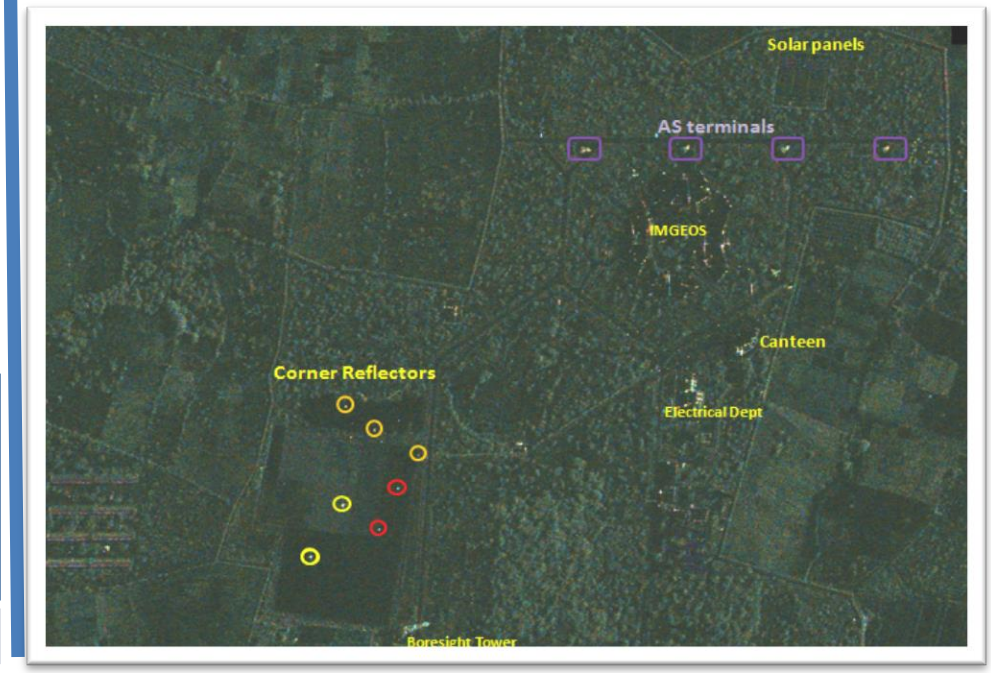
Geometry:

Spatial accuracy

Radiometry: **PSLR, ISLR, Radiometric Resolution, Calibration Constant.**

RISAT1/2B,RISAT2/Novasar

Targets for microwave sensors consists of corner reflectors of various dimensions to cater L- band / C–band / X-band frequencies
In Vertical, Horizontal &Circular polarizations.



BRDF Characterisation of Optical Targets

Indigenously built Goniometer

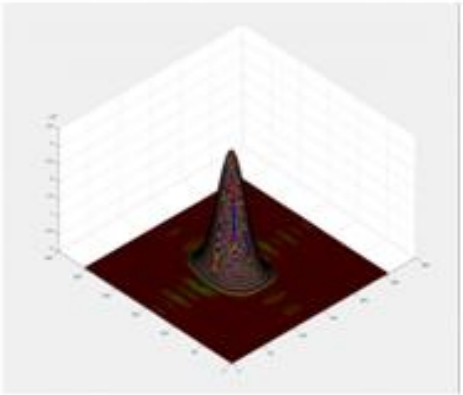
Fabrication and acceptance completed.

Target Characterisation is under progress.

Microwave Data Calibration

Microwave Data Calibration

Aid: By deploying suitable Corner reflectors with proper orientation acts as a point source for impulse response.
Types in Point source: Active and Passive.

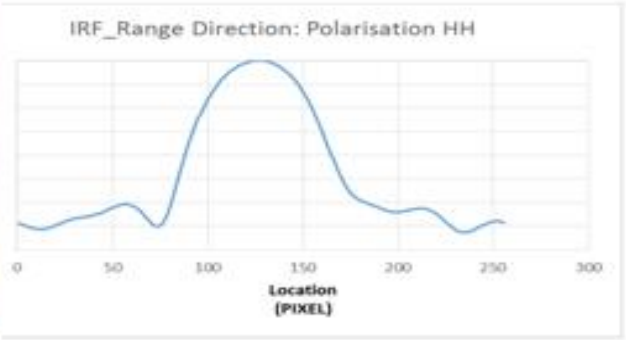


75 cm Square Trihedral

60 cm Square Dihedral

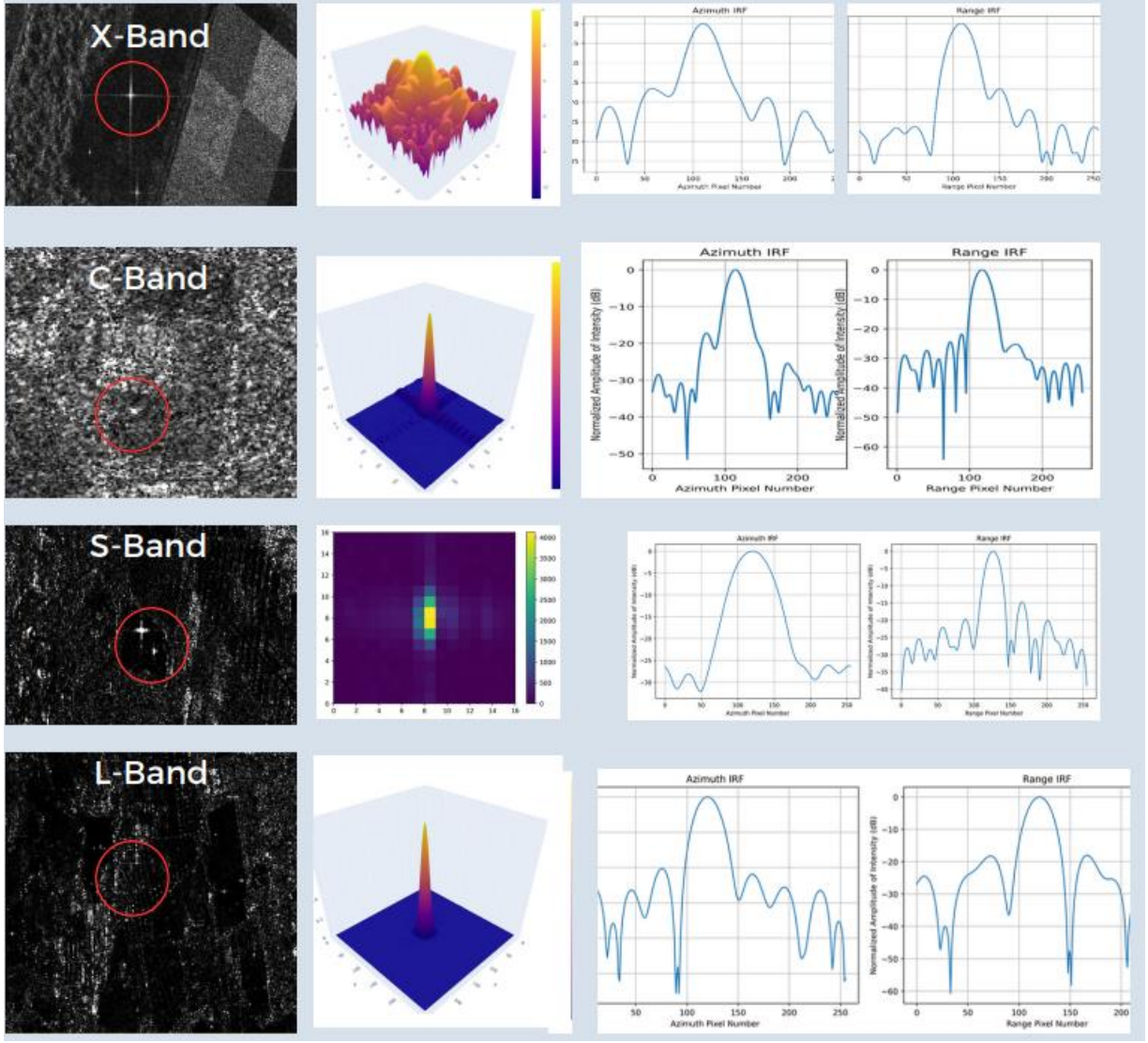
Distributed target: Like Amazon forest

ISRO Amazon Basin target

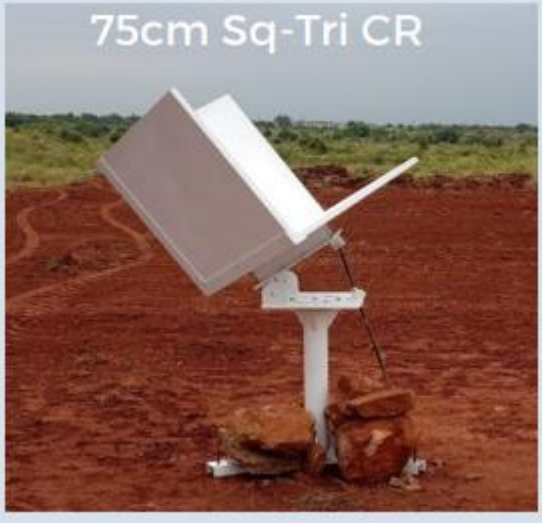


- ✓ Square Trihedral (for Co-Polarised Data)
- ✓ Square Dihedral (for Cross-Polarised Data)

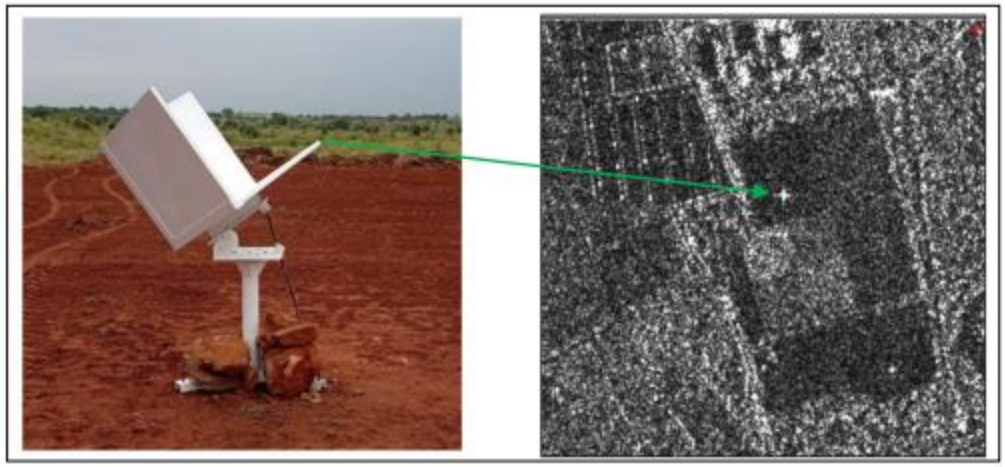
CR inventory - Results



Size (cm)	Type	Qty
60	Dihedral	2
100	Dihedral	2
40	Trihedral	2
75	Trihedral	5
125	Trihedral	2



EOS-4 stability

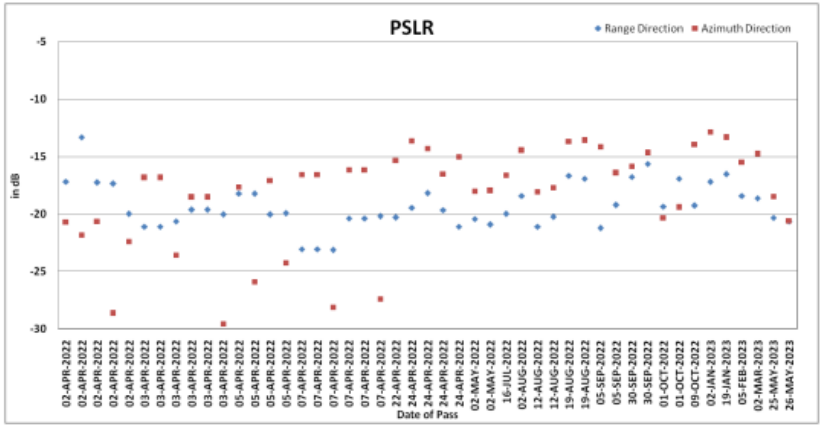


Stability of quality parameters using the corner reflectors in Shadnagar site for one year period

EOS-4 microwave imaging satellite launched by ISRO on 14-Feb- 2022

Imaging Mode	Swath in km	Off-nadir Coverage in km	Polarization	Resolution (Azi. x Sl Rng.)
FRS-1	25 #20	100-650 #100-400	Single, Dual, Circular, Full	3m x 2m
FRS-2	25 #20	100-650 #100-400		3m x 4m
MRS (8-Beam)	160 #115	100-650 #100-400		33m x 8m
CRS	223 #168	100-650 #100-400		50m x 8m
*HRS	10	100-650	Single, Dual, Circular,	1m x 2m

FRS- Fine Resolution Stripmap; MRS - Medium Resolution ScanSAR; CRS Coarse Resolution ScanSAR; HRS- High Resolution Spotlight.

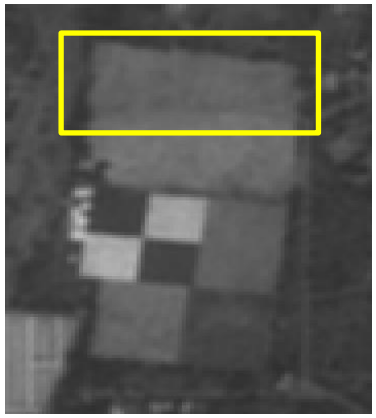


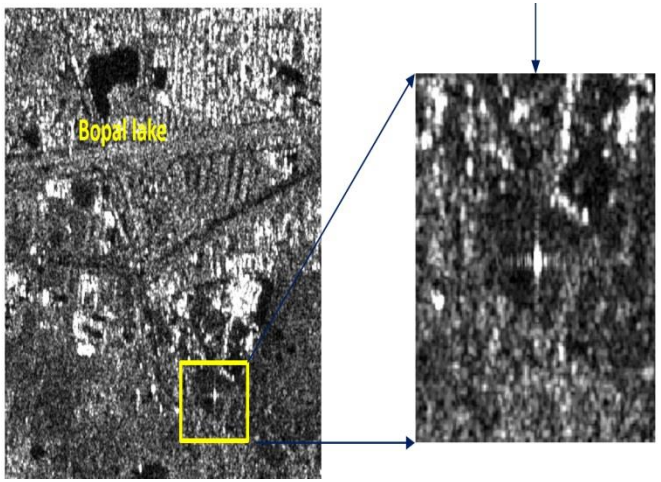
Microwave Campaign sites

Preparedness for NISAR

Readiness for NISAR

Extension of site to deploy newly developed corner reflectors



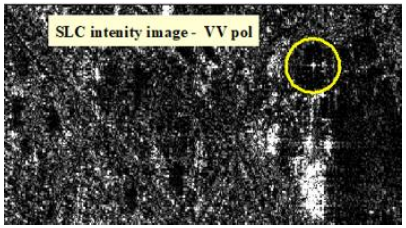


Corner reflector designed
developed for NISAR miss
deployed

Size: 1.5m

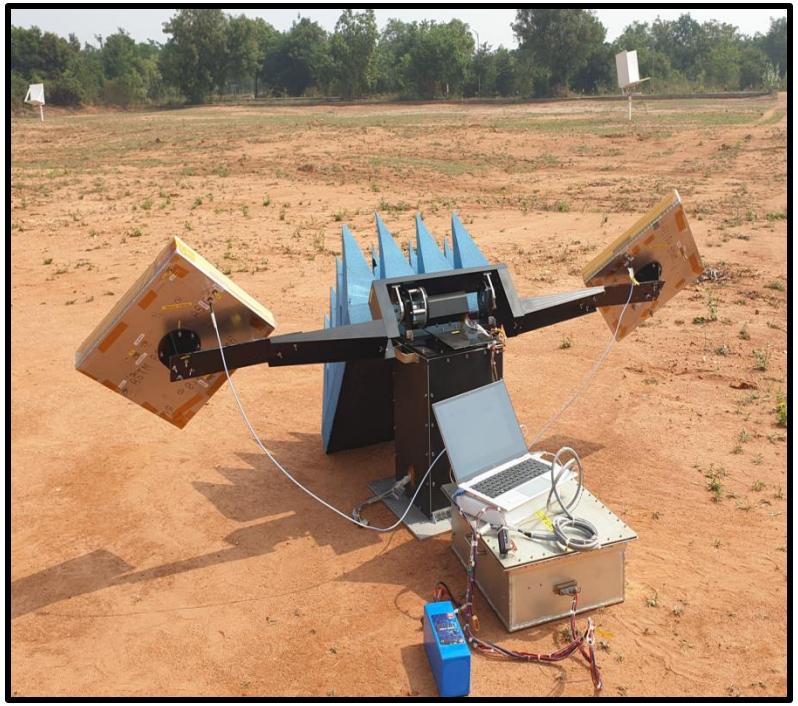
Shape: STH/ TTH

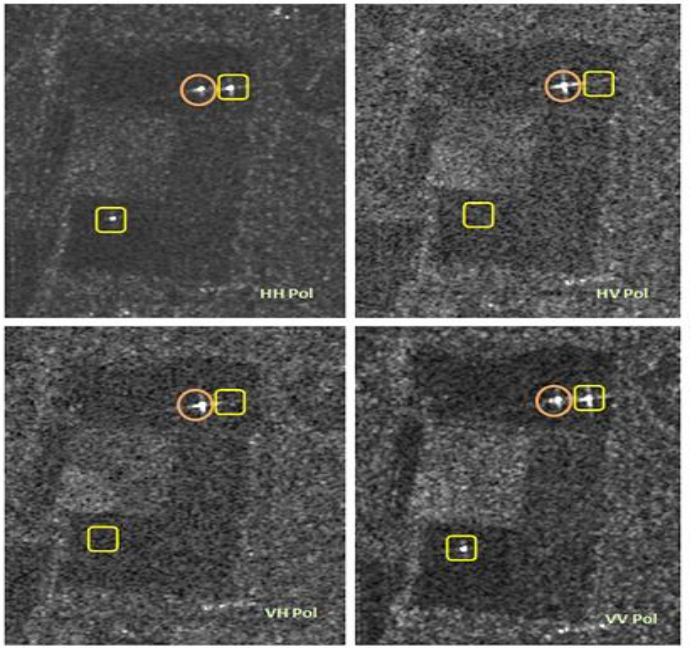
Ground snap of NISAR CR deployed at Bopal calibration site



ARC

ISRO's indigenously developed Multi-band Active Radar Calibrator (ARC) capable of performing radiometric, geometric and polarimetric calibration in single, dual, hybrid and full polarimetry (Co and Cross Polarization) for L, S, C and X band SAR missions



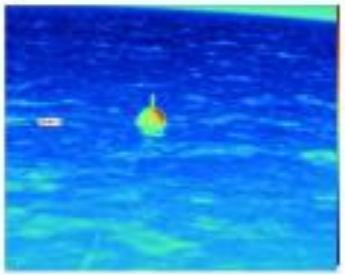


- Active Radar Calibrator
- Square Trihedral Corner Reflector

Thermal Data Calibration methods

Thermal Data Calibration

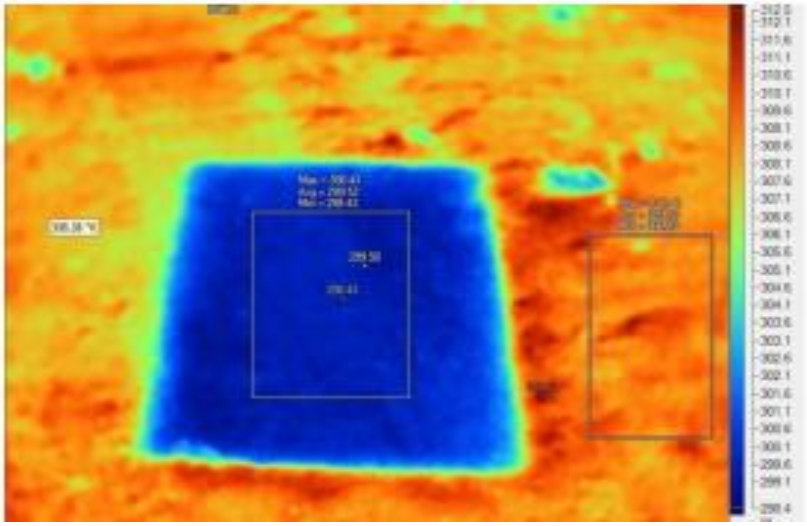


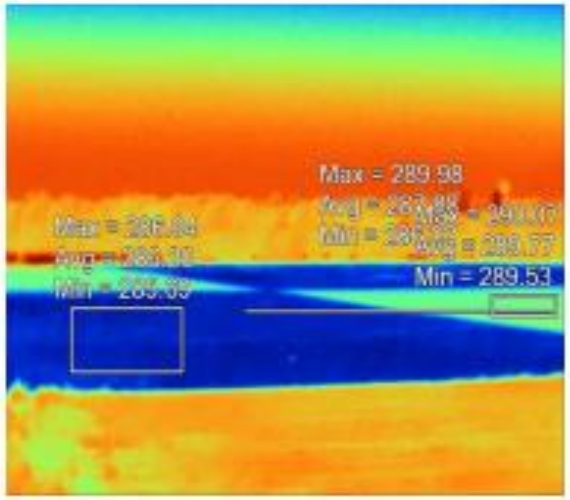



Row1: Satellite Image of Site, Measurement using TI400
Row2: Thermal Image of Buoy, Measurement using SBE.




Row1: NTC thermistor & PT100 RTD thermometer Probe , Seabird Salinity & Temperature sensor
Row2: Drifting Buoy (make - NIOT), Fluke TI 400 Thermal Imager.





Joint Activities

International:

- ISRO- USGS
- ISRO-LTWG
- ISRO-NASA/JPL
- ISRO-ASI
- CEOS - WGCV

National:

- DRDO
- Space – Private Companies
- SAC

Few Field Campaigns

Iron Ore Mine:
Donnamai, Karnataka

ICRISAT-Ground measurements

Rajasthan desert
Ground measurements

Novasar Ground
Processing Team with
deployed CR

Dundi Field Experiment , HP

CIMEL calibration- Abu

CAL-VAL Teams:

National Remote Sensing Center(NRSC), Hyderabad, ISRO
Space Application Center (SAC), Ahmadabad, ISRO

Q/A

Thank You..