



<ISRO>

Report on Cal/Val Activities

Arundhati Misra

ISRO

Agenda Item #

WGCV # 45,

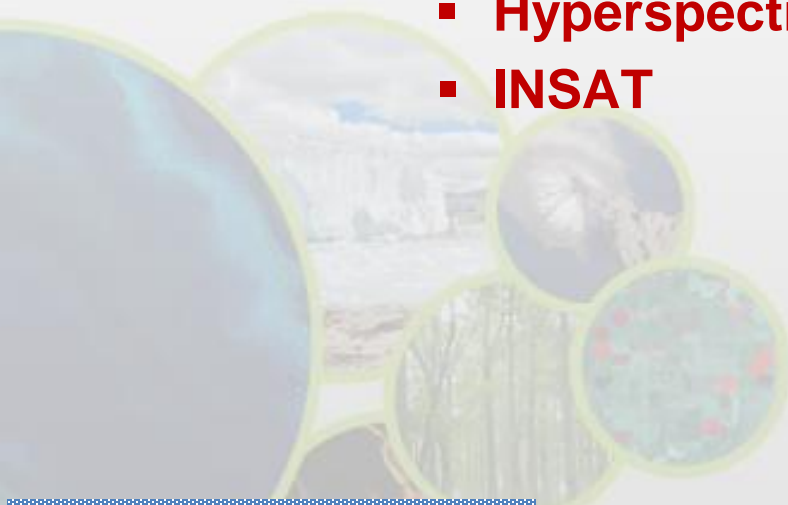
PERTH, AUSTRALIA

16-19 JULY, 2019





- Agency reporting
- **ISRO – Dr. Arundhati Misra**
- Updates on the Calibration and Validation activities in ISRO
 - **TOPICS**
 - **SAR / MW**
 - **Hyperspectral**
 - **INSAT**



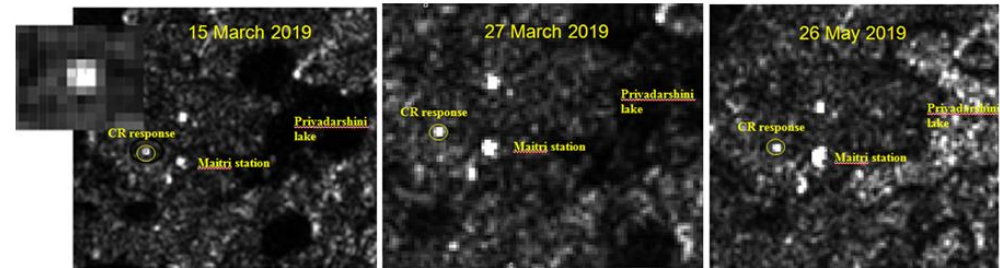


Microwave Sensor/Data Calibration/Validation

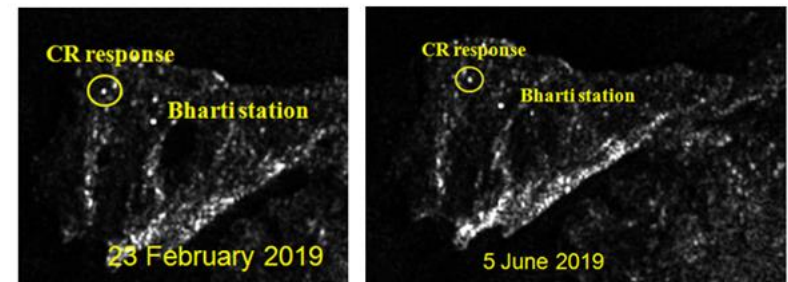
- **SAR calibration site established at Antarctica**
- **Establishment of Cal/Val site in Hyderabad**
- **Validation Experiments in NE Forests for PolInSAR**
- **ScatSAT-1 data calibration**
- **SARAL Altika calibration**

➤ A permanent SAR calibration site has been established in Antarctica by SAC-ISRO during 38th Indian Scientific Expedition to Antarctica (ISEA).

➤ This CR network will not only help in the SAR calibration but will also aid the studies related to ice velocity estimation, land deformation studies and can also be used as reference points for generating the precise DEM



Response of Maitri CR as seen in Sentinel-1 image of different dates



Response of Bharti CR as seen in Sentinel-1 image of different dates

SAC-ISRO team
(38 ISEA)

Future Plan

In the forthcoming Antarctica expedition, it is planned to expand CR network by deploying more CRs at different locations on the ice sheet.

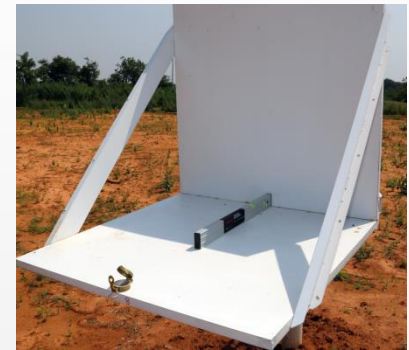
SAR Calibration Activities in Hyderabad:

Regularly conducting the SAR External Calibration exercises at IMGEOS Microwave Cal-Val Site to perform geometric, radiometric and polarimetric calibration for IRS/Non IRS missions for Space borne and Airborne SAR Sensors operating in various frequency bands and Polarizations using corner reflectors of different dimensions and shapes .

Space borne SAR: RISAT-2(X-band), RADARSAT-2 (C-band) and High Resolution X-band SAR of better than 1 meter accuracy with spot light mode data.

Future Program

Utilization of IMGEOS microwave CAL-VAL site, development and deployment of corner reflectors to cater to current/future RISAT series, NovaSAR, NISAR and airborne SAR sensors.



- ScatSAT-1 operational version
- Results from slice-wise analysis of Gamma-0 reflects good quality data of ScatSAT-1.
- For Amazon rain-forest site, average difference in aft and fore slices is within 0.3 dB, whereas, for reprocessed OSCAT data, the difference is within 0.6 dB for inner beam (HH). For VV difference is within 0.2 dB for both ScatSAT-1 and reprocessed OSCAT data
- For Antarctica site average difference in aft and fore slices is within 0.2 dB for ScatSAT-1, whereas, for reprocessed OSCAT data, the difference is within 0.4 dB for inner beam (HH). For VV difference is within 0.3 dB for ScatSAT-1 and 0.2 dB for reprocessed OSCAT data



SARAL ALTIKA

Mis-pointing status



Over full range of mis-pointing, data availability is almost 70 %.

Based on SARAL/Altika data and buoy observations along with Jason reference satellite mission a mis-pointing of antenna upto 0.316 deg is admissible.

Below this mis-pointing range the availability of good quality data is almost 98 percent with rejection rate of approximately 2%

The RMSE of the SWH, wind and SSHA are 0.45m, 1.72m/s and 15 cm respectively which are within mission requirement.

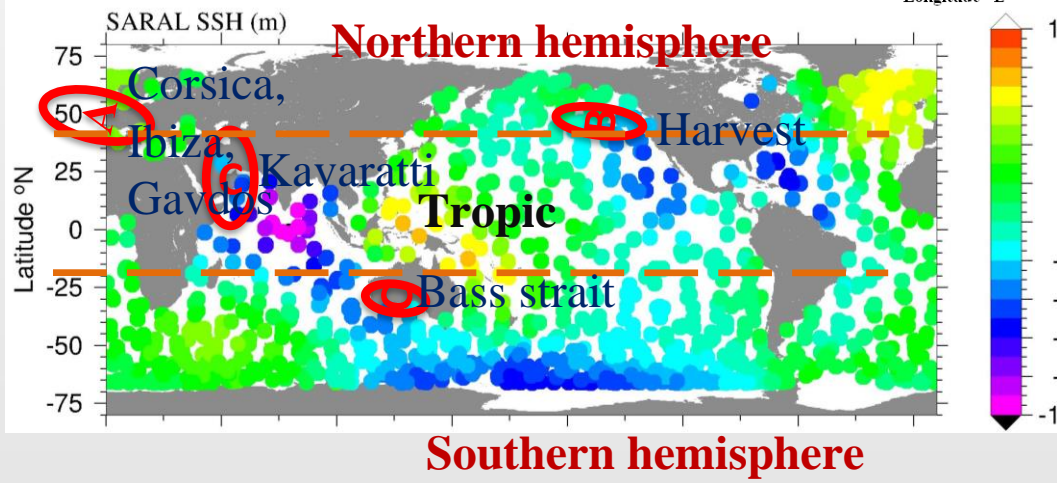
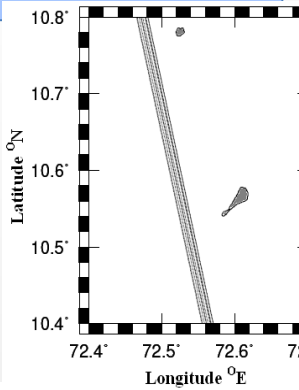
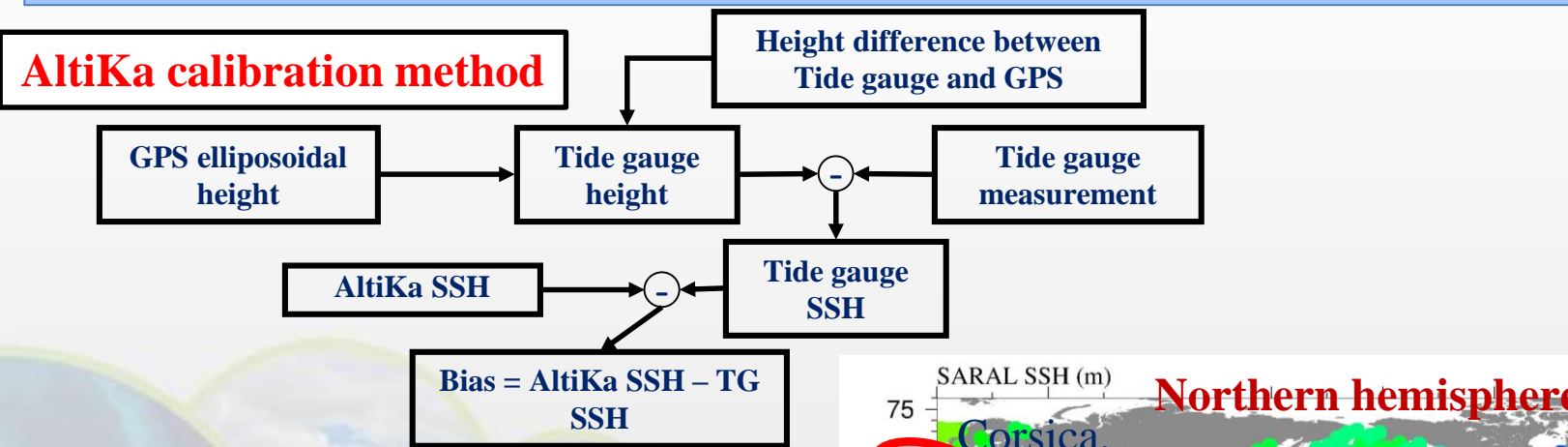
SWH data is marked with a distinct cluster, between 20-25 m and can be potential candidate for bias correction. However the variation of mean absolute bias of the SWH wrt observation shows, its non-linear relationship with mis-pointing angle. Thus a mis-pointing dependent bias would be more suitable candidate rather than a unique bias correction value.

Unedited version of SWH can cause large standard deviations in the operational models. Mis-pointing threshold criteria is must for assimilation of the data. Using edited data set the SWH data is useable in operational oceanographic models.

Negative SSHA is most affected by the mis-pointing error rather than positive SSHA.

SARAL AltiKa: Calibration

- ❖ The very first tropical calibration site for altimeters is developed at Kavaratti site.
- ❖ Joint calibration experiment between ISRO and CNES was conducted at Kavaratti site with GPS buoy, GPS reference station, BPR(bottom pressure recorder), and tide gauge for following international standards.
- ❖ The CNES standardized calibration procedure has been followed, for calibration of SARAL/AltiKa and Jason-2 sensor using tide gauge observations.

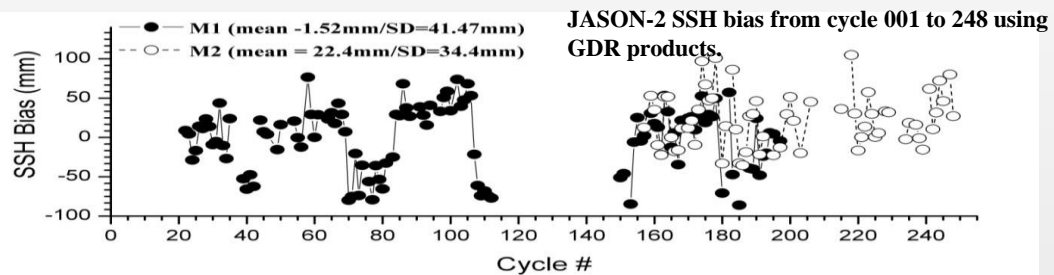
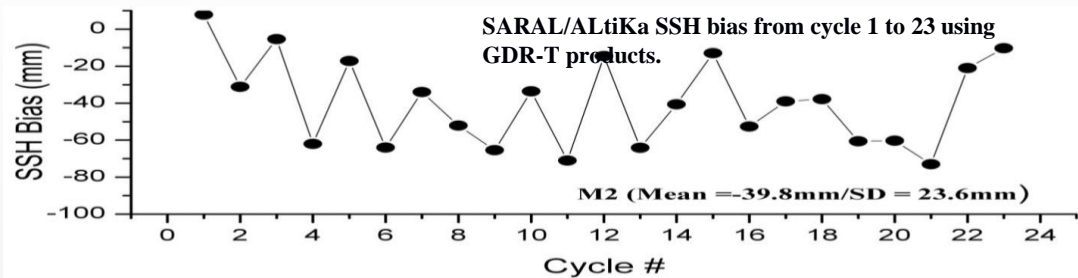
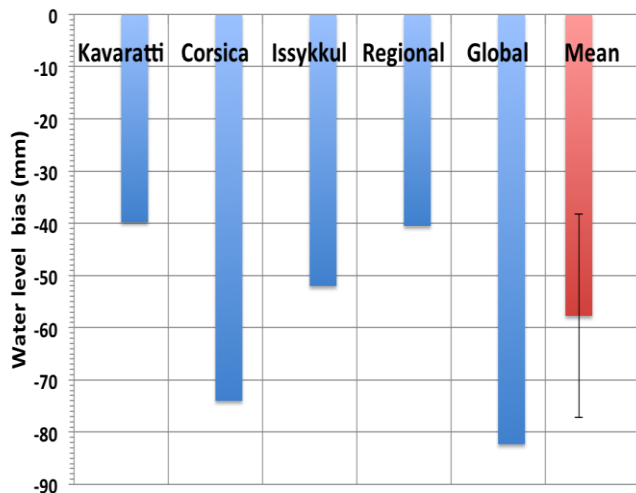


“The principal of the method is to estimate the bias by means of comparison of altimetric sea surface height information to adjacent tide gauge sea surface height data located within the same geodetic reference frame”.

Kavaratti calibration site for SARAL/AltiKa



SARAL/AltiKa SSH

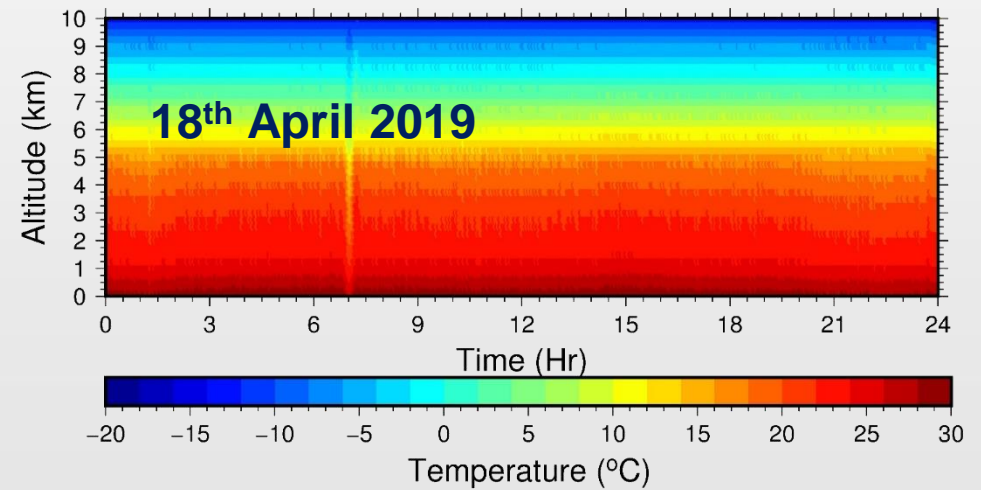
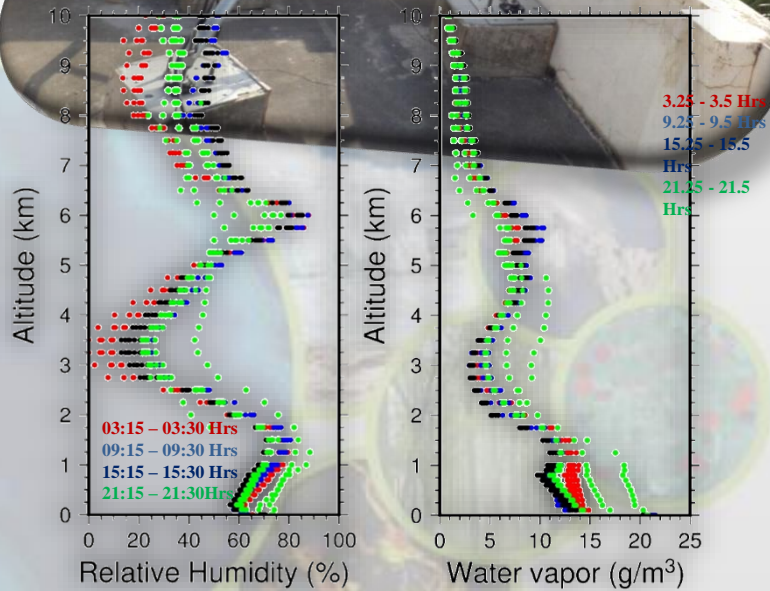


- ❖ 23 cycles of Saral/AltiKa and 248 cycles of Jason-2 SSH absolute calibration using Kavaratti site observations is being carried out.
- ❖ AltiKa/Jason-2 has $-39.8 \pm 23.6 \text{mm}$ / $22.4 \pm 34.3 \text{mm}$ in terms of its absolute bias which are meeting the mission required specifications.

Microwave Radiometer (MWR) installed for Temperature and Humidity profile at Kavaratti



- ❖ An all weather microwave radiometer(Radiometrics) operating in K band (22-30 GHz) and V band (51-59 GHz) installed at roof-top of Kavaratti Cal-Val laboratory.
- ❖ Measures brightness temperatures in both water vapor and oxygen bands every minute.
- ❖ Measures cloud base temperature and height with IRT.
- ❖ Pre-designed Neural Network retrievals provide temperature, water vapor, relative humidity, and liquid profiles upto 10 km.





Pol-InSAR Algorithm Development for Forest Height Retrieval : CaVal at Saipung Reserve Forest, India

Reconnaissance survey was conducted at Saipung reserve forest in October, 2018 under rainy conditions followed by an extensive GT in December, 2018.

Precision Laster instruments (Haglöf Sweden Vertex Laser 5) were used in measuring forest stand height (15mx15m area)



Pauli decomposed imagery of study area (ALOS-2 PALSAR, 17/12/2018) with some GT points overlaid

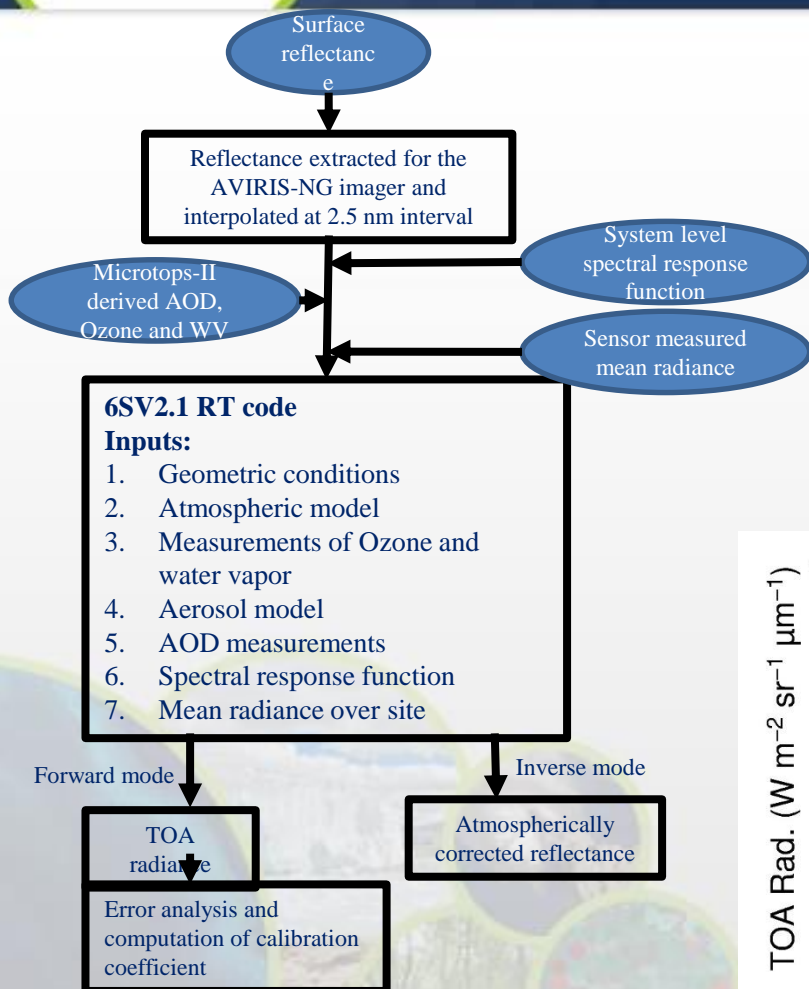
Good results are obtained ; work in progress



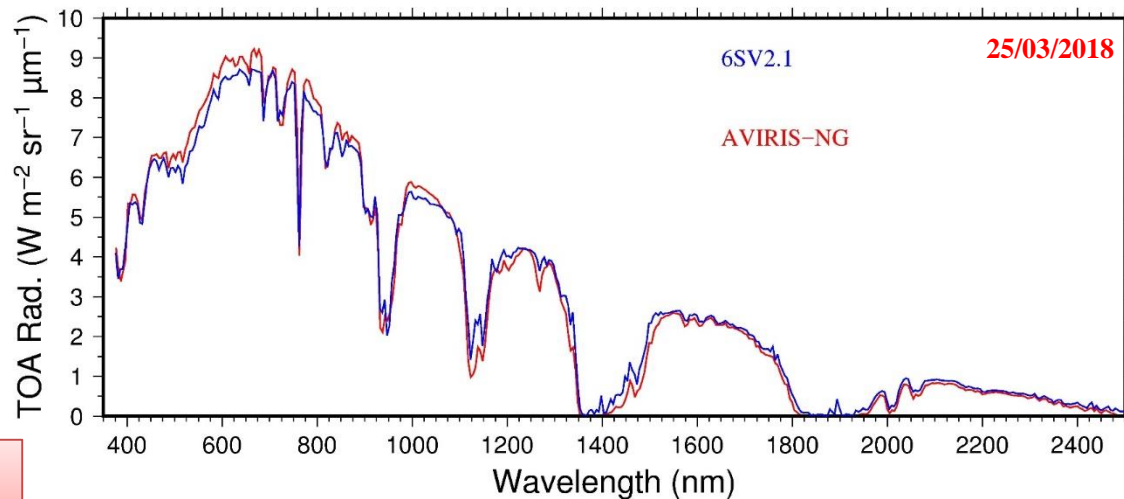
Hyperspectral Data Calibration/Validation



AVISIR-NG Vicarious Calibration (Phase-2)



Desalpar



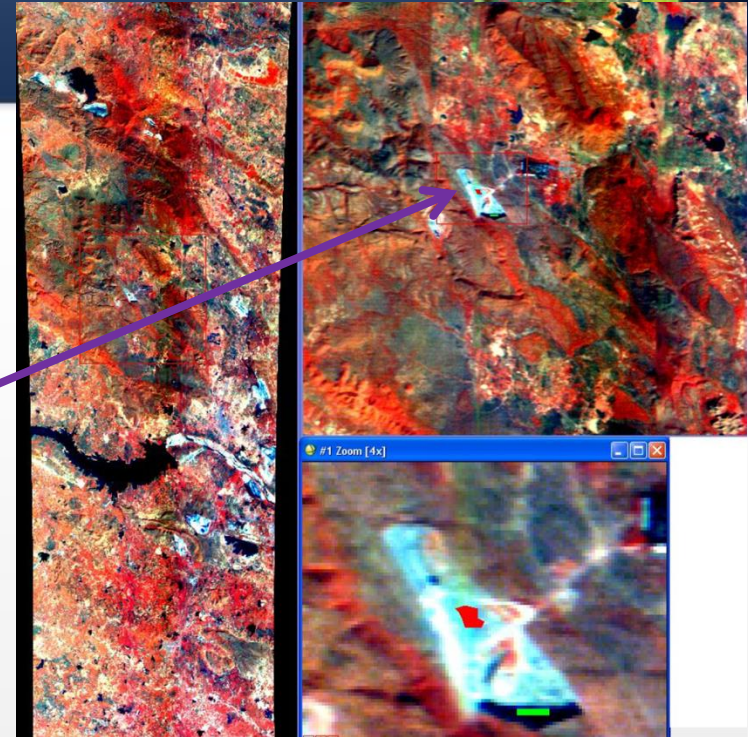
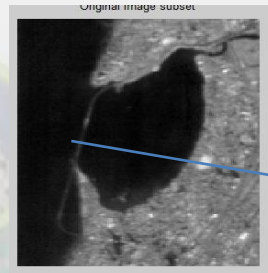
Flow chart of TOA spectral radiance simulation and estimation of calibration coefficient

Natural targets: Vegetation, water and soil
 Mineral beds: Lime stone and Iron Ore bed

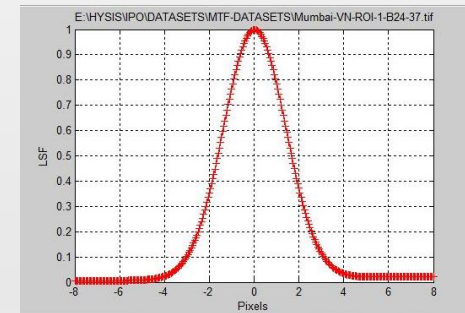
- ✓ At 2390nm interesting absorption related lime stone is observed with spectral signature collected through radiometer which is matching with library spectra.



Lime stone – exposed ore bed



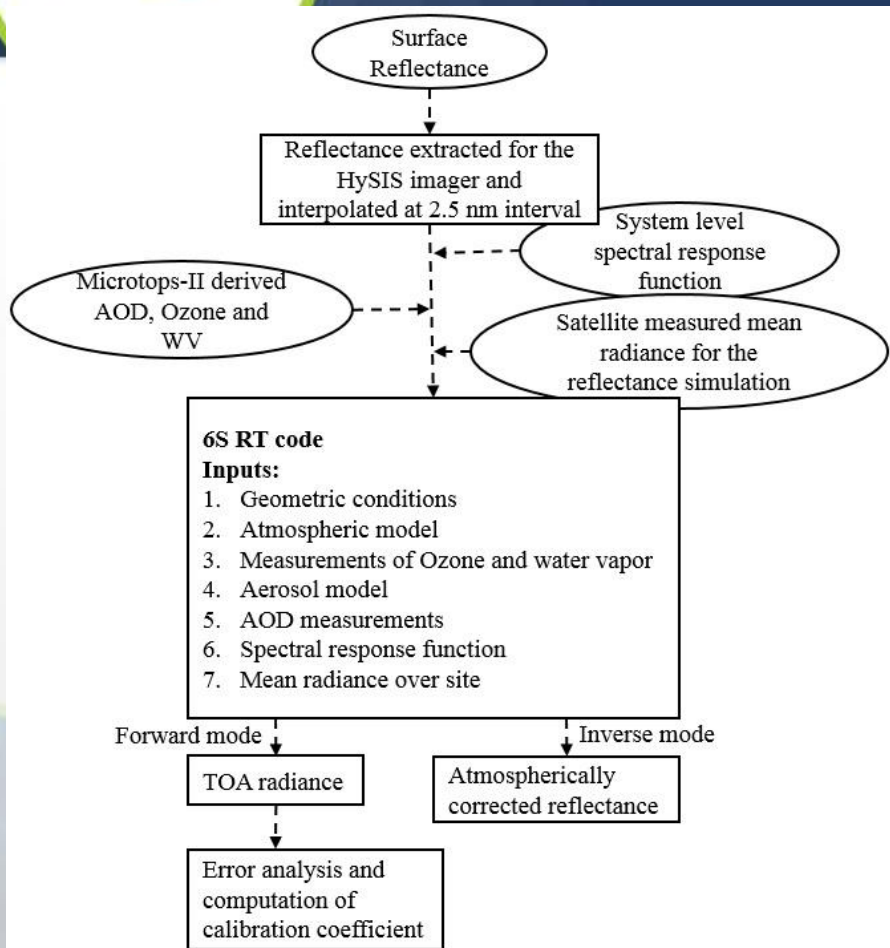
HYSIS Data collection over Lime stone ore bed



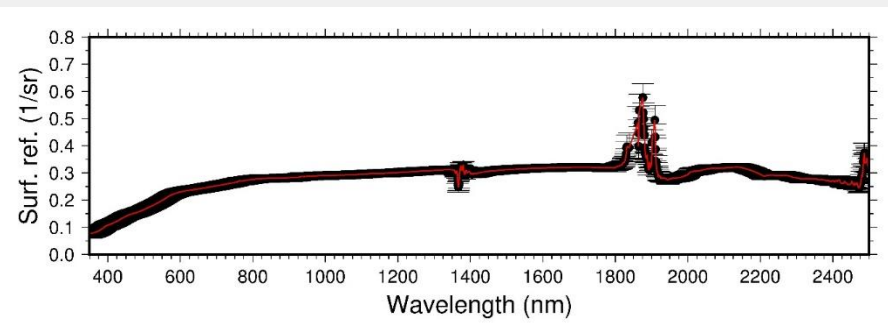
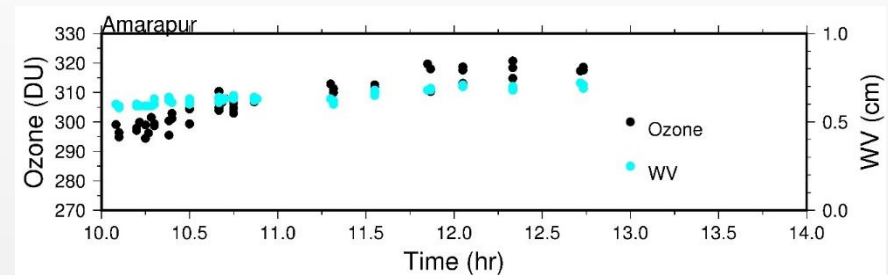
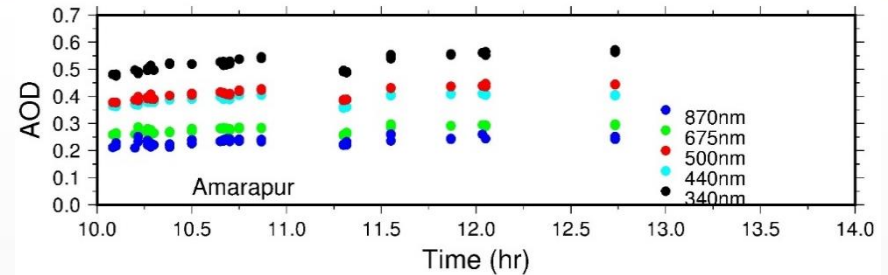
LSF construction

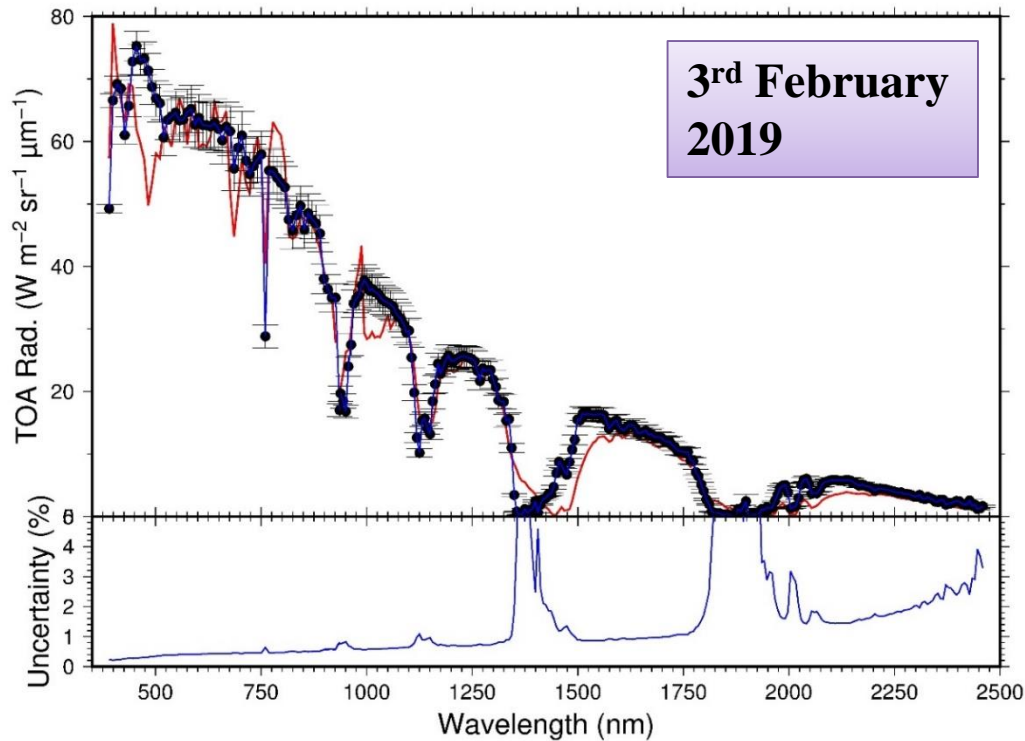
➤ Long bridges were used for HYSIS MTF computation.

- ❖ AVIRIS-NG – Soil response was used for comparative relative radiometric performance of HYSIS.



Flow chart of TOA spectral radiance simulation and estimation of calibration coefficient





Source of Uncertainty	Percentage of uncertainty
Aerosol optical depth	5.99
Integrated water vapour	3.71
Integrated Ozone	0.12
6S model	~3 (maximum)
Surface reflectance measurements	
Spectralon panel calibration	0.3
Ground measurement errors	17
Inherent code accuracy	0.6
Total uncertainty (root sum of squares)	18

HySIS bands performance (solid red line) against 6S simulation for Urban aerosol model solution (solid blue line).



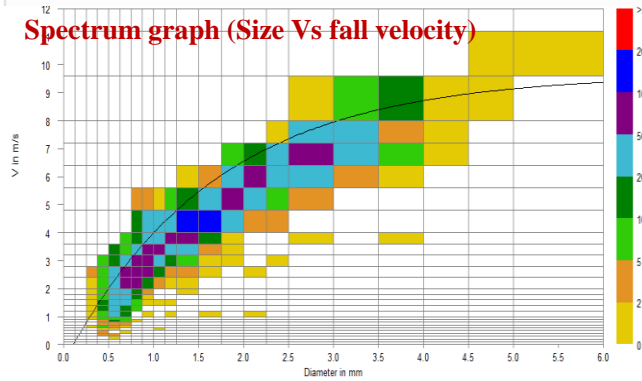
Optical Disdrometer network for rainfall validation over BHOPAL



Disdrometer: optical type

Current Weather	
10-07-2018	
00:10:03	
Heavy Rain	
Current Status: Static Info	
Name	Value
Intensity of precipitation (mm/h)	86.515
Precipitation since start (mm)	173.86
Weather code SYNOP W/a/a	63
Weather code SYNOP W/W	65
Weather code METAR/SPECI	+RA
Weather code NWS	R+
Radar reflectivity (dBz)	52.031
MOR Visibility (m)	346
Measuring interval	0060
Signal amplitude of Laserband	22065
Number of detected particles	2832
Temperature in sensor (°C)	24
Heating current (A)	2.00
Sensor voltage (V)	23.9
Sensor status	0
Kinetic Energy	1986.070

Spectrum graph (Size Vs fall velocity)

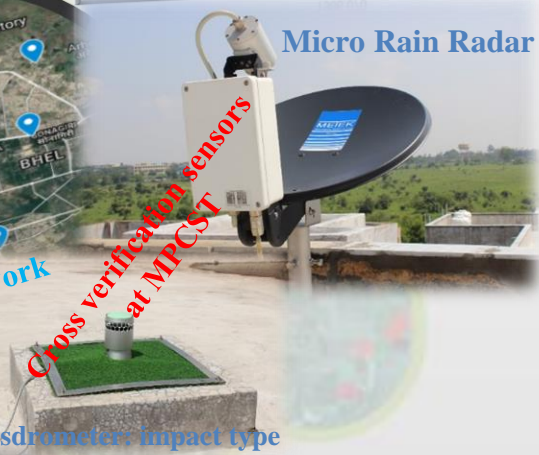


A network of Disdrometer over Bhopal urban region for the validation of INSAT-3D/3DR derived rainfall data.

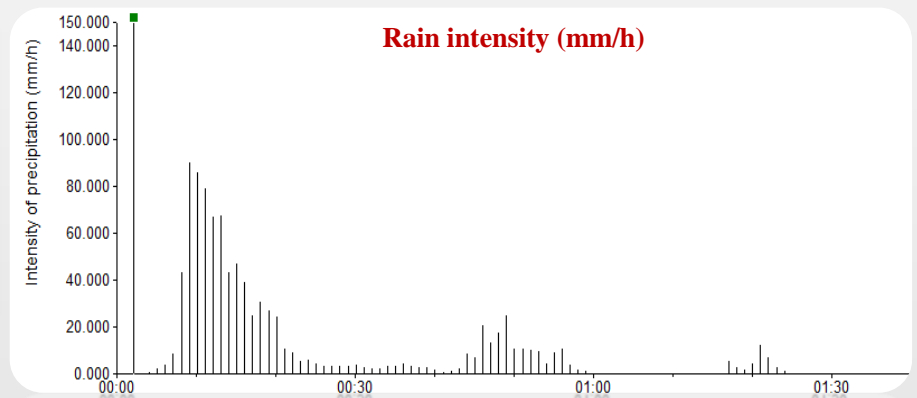


Disdrometer network

Micro Rain Radar



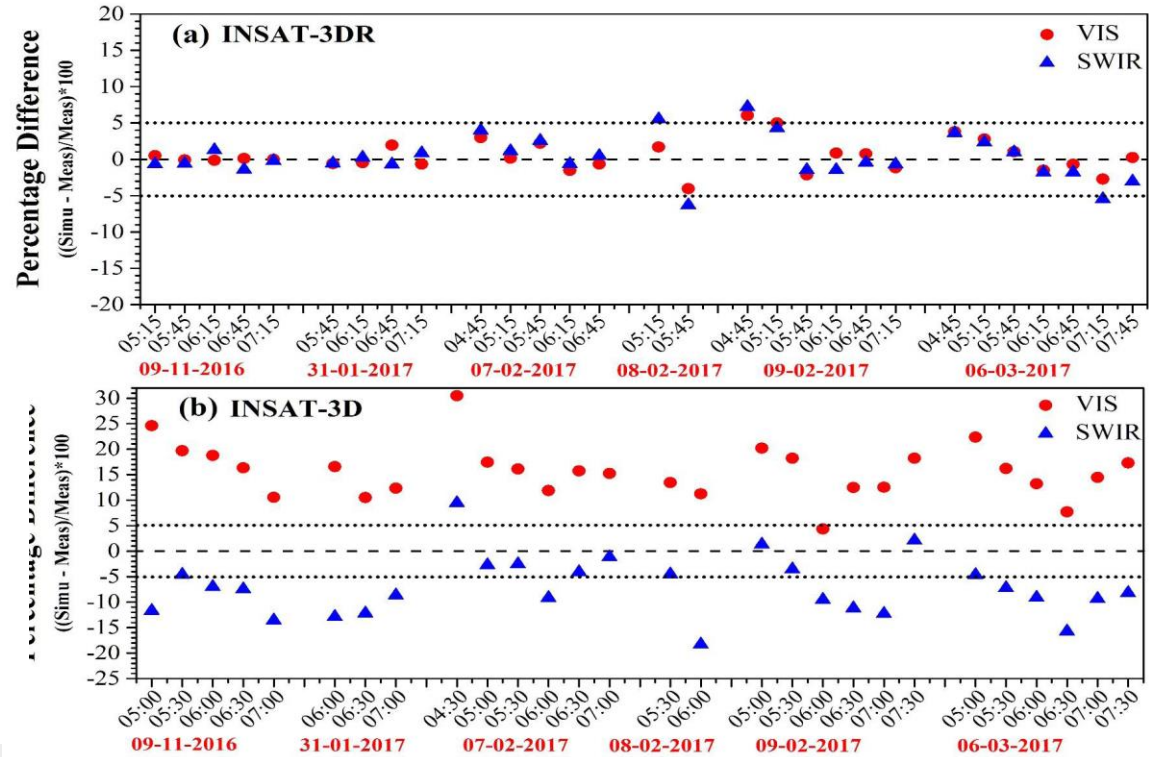
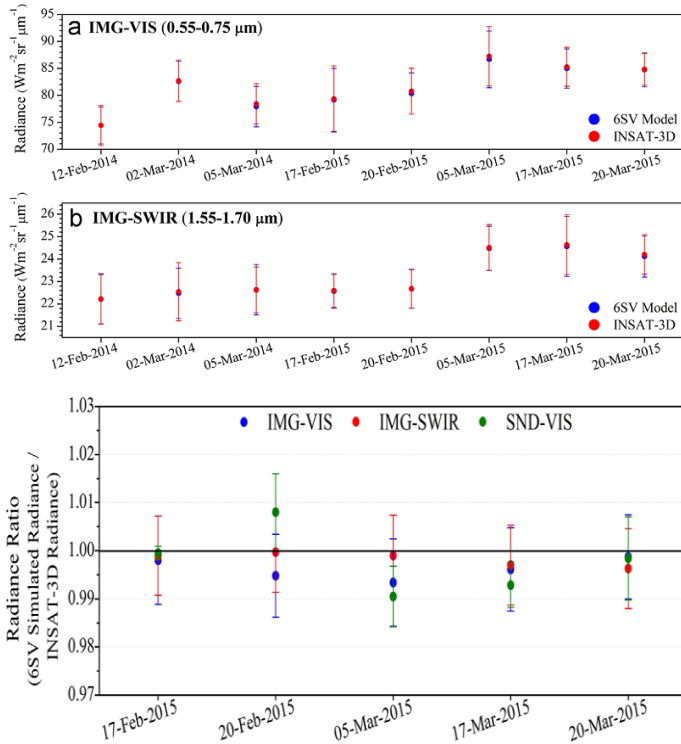
Disdrometer: impact type



Rain intensity (mm/h)

CVD/EPISA, Cal-Val team

Vicarious calibration of INSAT-3D, -3DR



- ❖ Vicarious calibration coefficients are computed to be 1.277 and 0.903 for VIS and SWIR of INSAT-3D, respectively.
- ❖ A significant change in VIS and SWIR bands of INSAT-3D was found from the year 2016 and calibration gain coefficients are applied at data product level.

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

Targets: Optical

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

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/SWR estimation) 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 Landsat 8/7 calibration results were demonstrated - Facility is demonstrated to DLR Team Jan 2018 (ISRO-DLR Meet) & Komsat Team



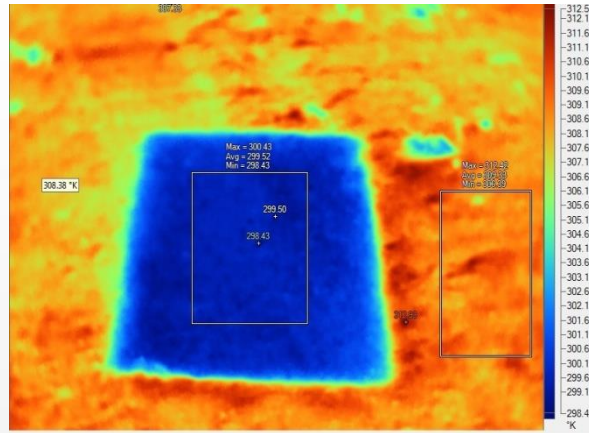
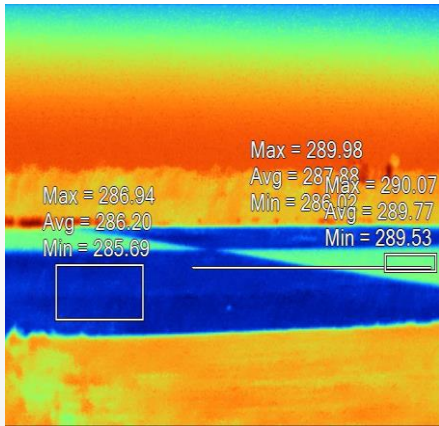
Favorable period for experiment: October to May



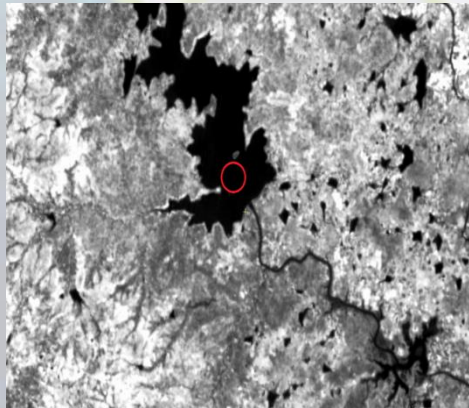
Rajasthan (India) CALVAL Experiments

Thermal Data Validation (New activity)

Gradient simulation for high resolution thermal data for high resolution sensors



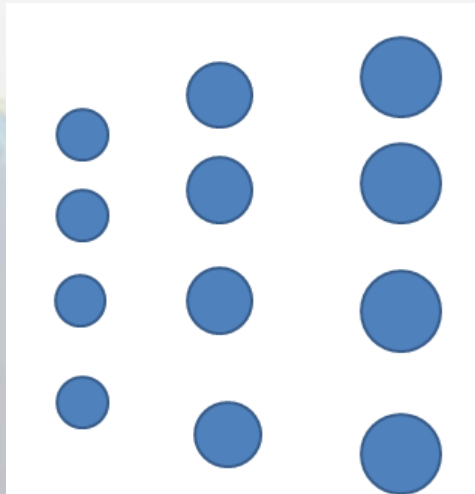
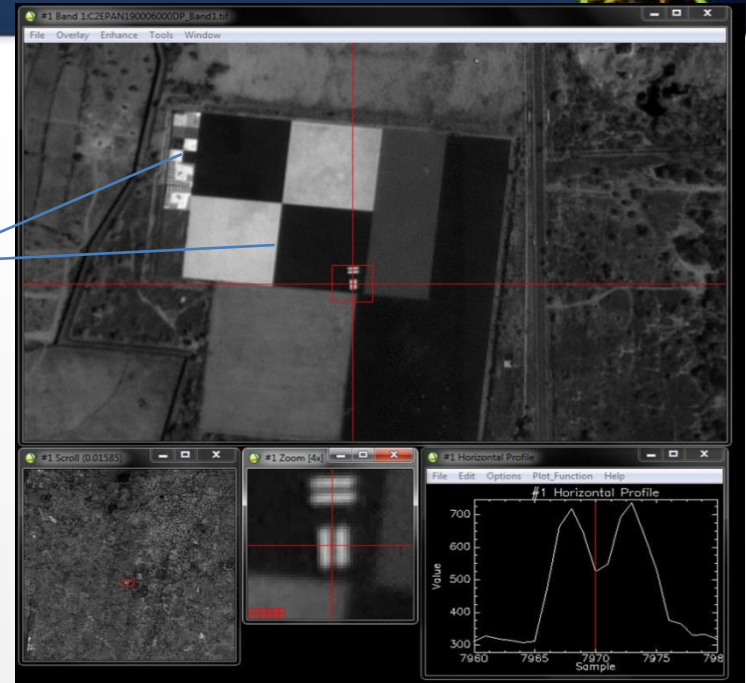
Water Body experiment : Landsat8 Thermal channel data validation (for Mid resolution)
 Proposed for IRS upcoming thermal sensors.



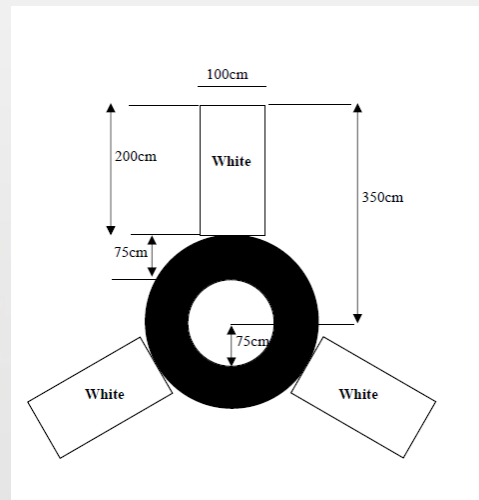
Landsat8, B10 data is found to be within 1 deg Kelvin

- BAR Targets : Paint type - for 5cm to 130cm resolution**
cloth type (customised)
<1.6m to > 6m
- **Mirror targets**
 - **Cloth type – Set of Point targets (preparation under progress)**
 - **Grey scale targets**

Edge based MTF target



Point targets with different resolutions from 30cm to 60cm



Customised GSD based GCP – for very high resolution.



THANK YOU

