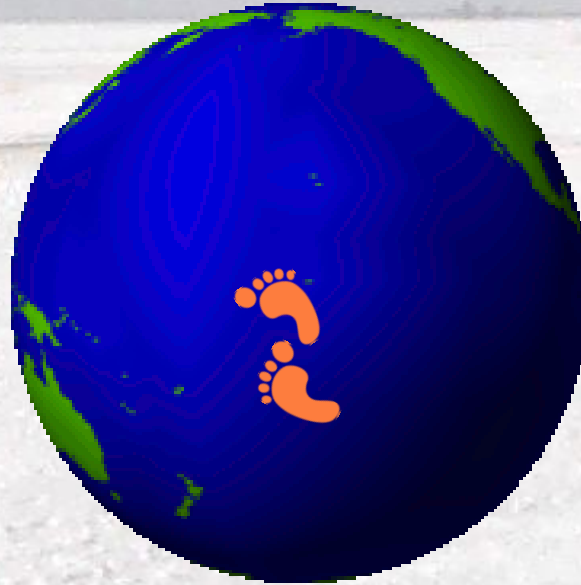


Site characterization for LSI and Lunar Cal

Indian footprints on Cal/Val Route



B Kartikeyan
Space Applications Centre (ISRO)
Ahmedabad-India

Presentation overview

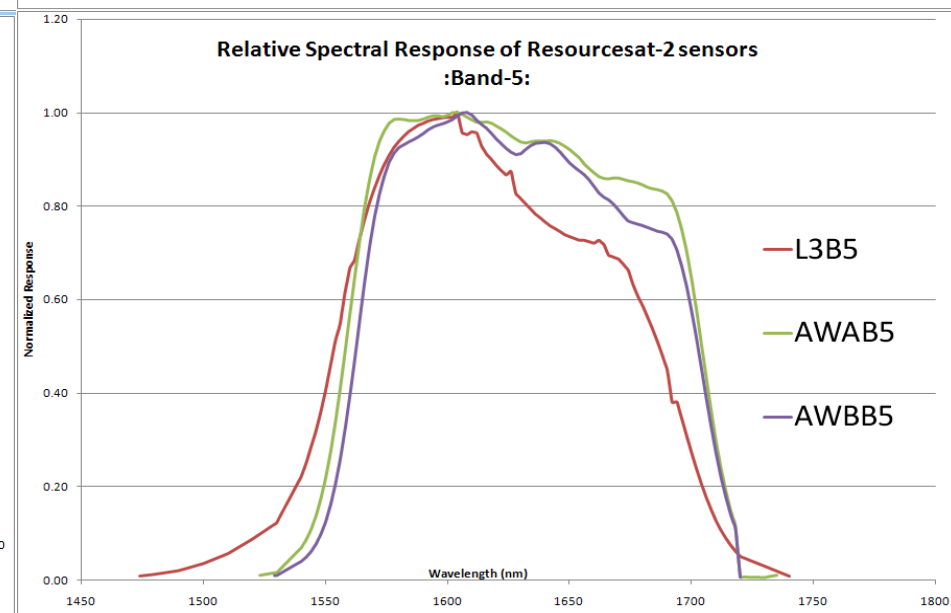
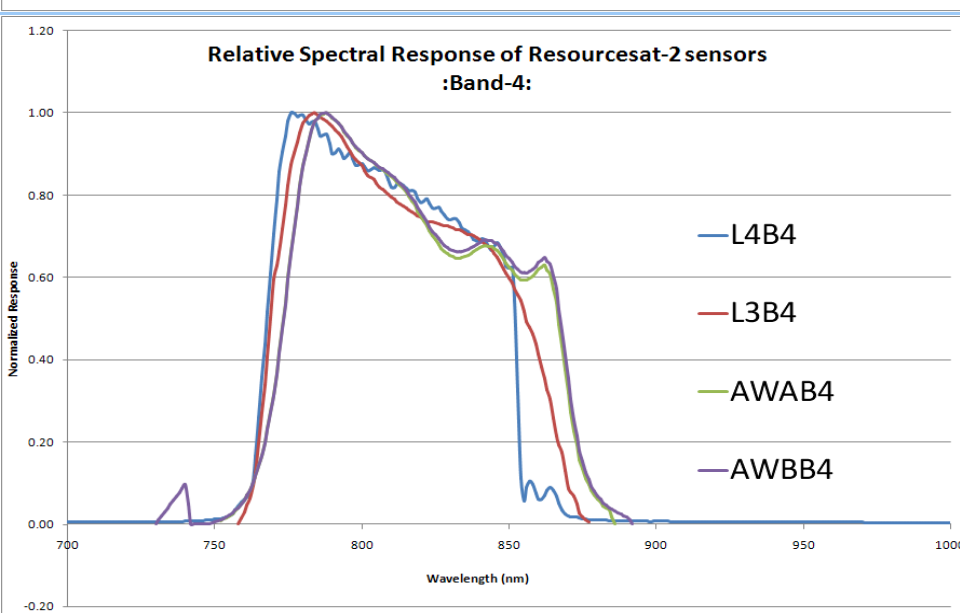
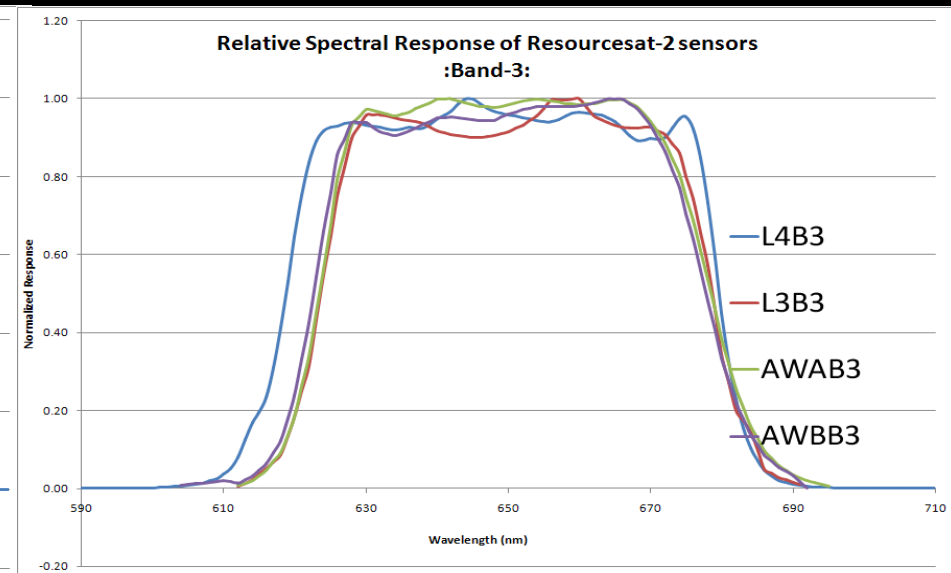
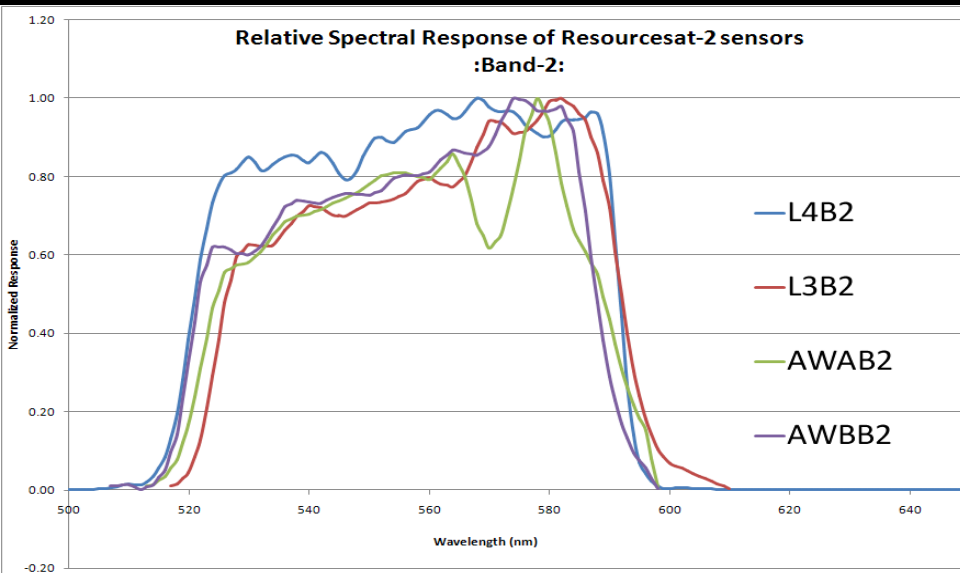
- ✓ Identification and Characterization of radiometric sites for medium resolution Optical sensors like Resourcesat-2
 - Tryst with artificial targets
 - Lunar calibration (Lun-cal)
 - Inter-sensor cross calibration (X-cal)

Target System: Resourcesat-2 Specifications

Parameters	AWiFS	LISS3	LISS4
Spatial Resolution	56m	23.5m	5.8m
MTF* (%)	B2,B3:70 B4:65 B5:50	B2,B3:70 B4:65 B5:50	B2,B3,B4>40
Swath	730km	141km	70km
Radiometric Resolution	12 bpp	10 bpp	10 bpp
Applications	Natural resource assessment at regional scale, land cover/ land use mapping, change detection, forestry,	Land-use land cover detection, Natural resource monitoring, crop production forecasting, forestry	Natural Resource monitoring, enhanced crop discrimination, disaster monitoring

*: System Requirements Document for Ground segment processing NRSC-DPA-DPSD&DBS Feb'10-TR150(RS2-SyRS)

Spectral comparison of Resourcesat-2 sensors



Field Instruments



ASD Spectroradiometer



Microtops sunphotometer/ozonometer



SVC's Spectroradiometer

Instrument Calibration

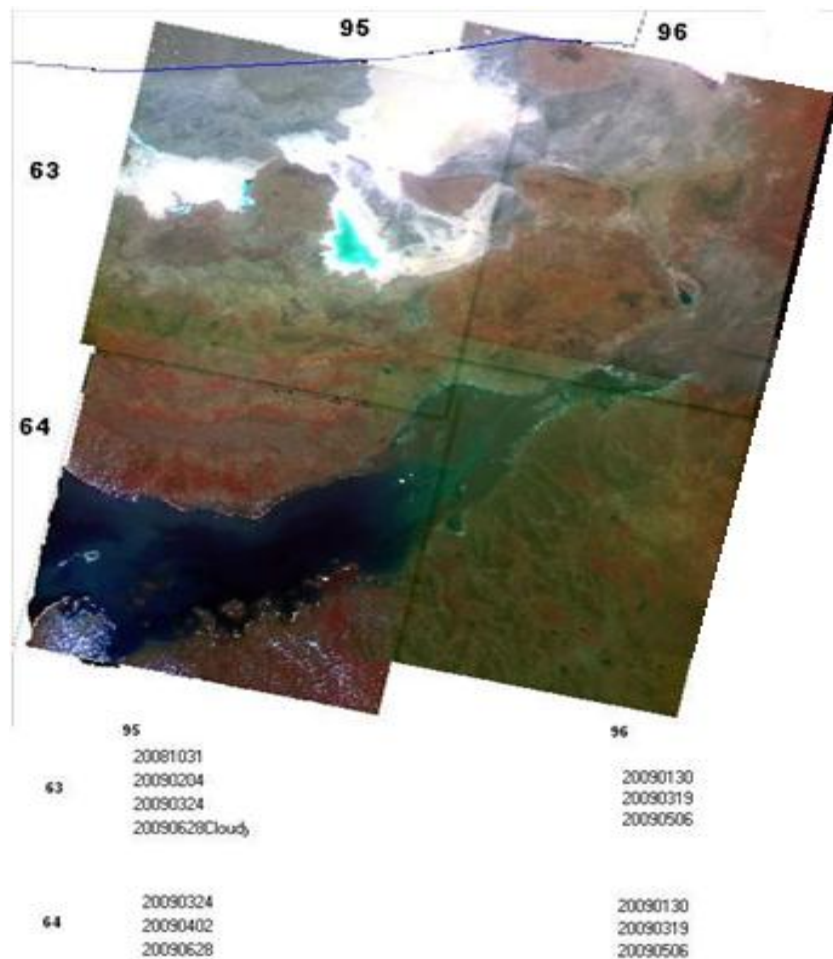
- Field instruments are periodically calibrated using in-house calibration facility
- High-altitude calibration of sunphotometer / ozonometer is also carried out at Mt. Abu Observatory situated at 1800 m height



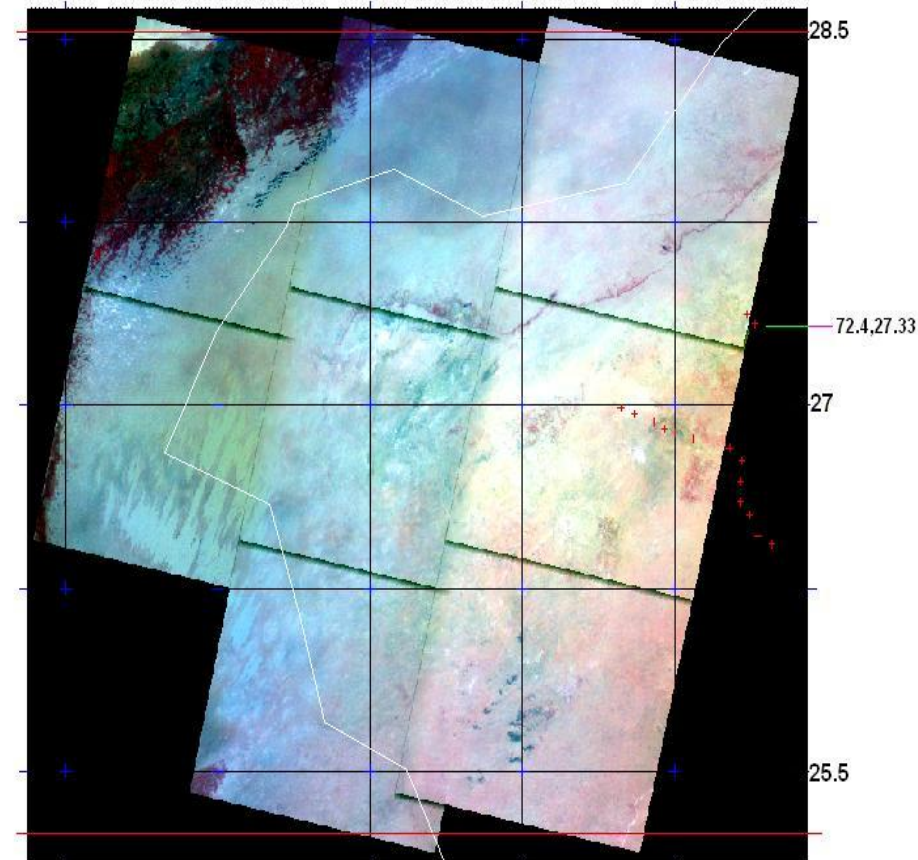
CEOS Joint meeting of WGCV-35 24-28 Sep 2012 Hyderabad India

Multi-temporal data analysis

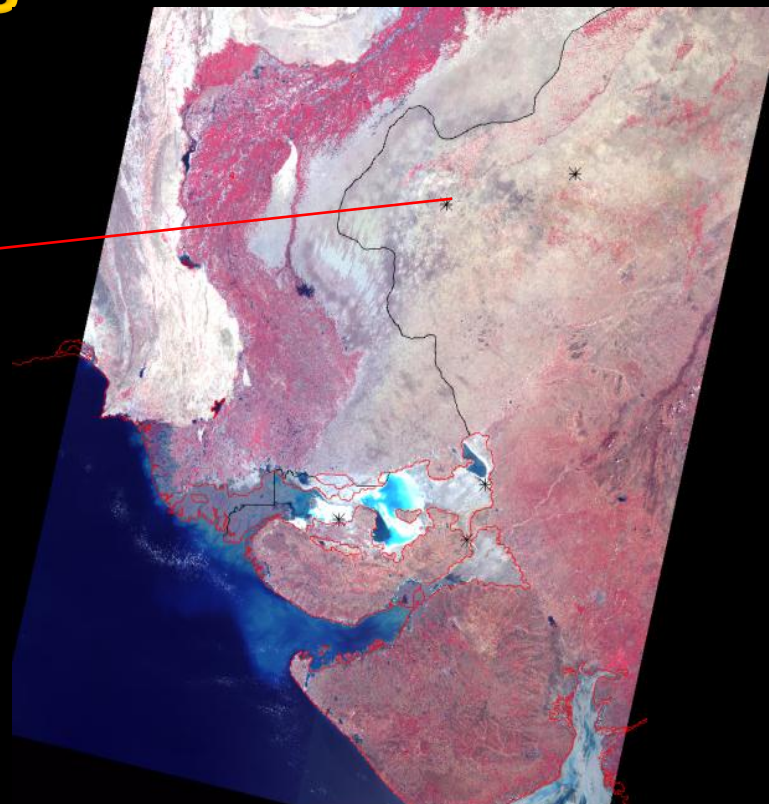
(Source: IMS-1 HySI and Resourcesat-1 LISS3)



Gridded mosaic of THAR region showing point of data collection and International Political Boundary in low resolution



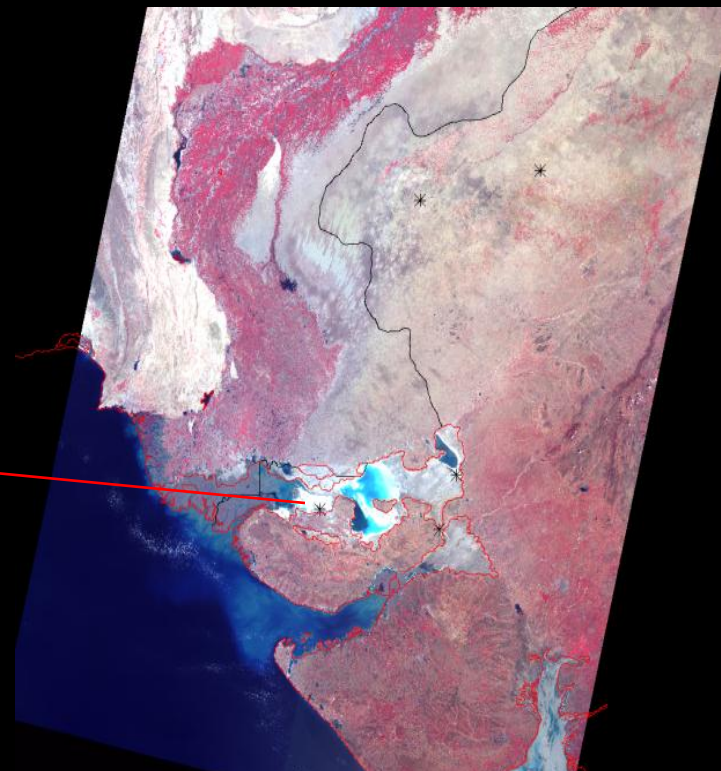
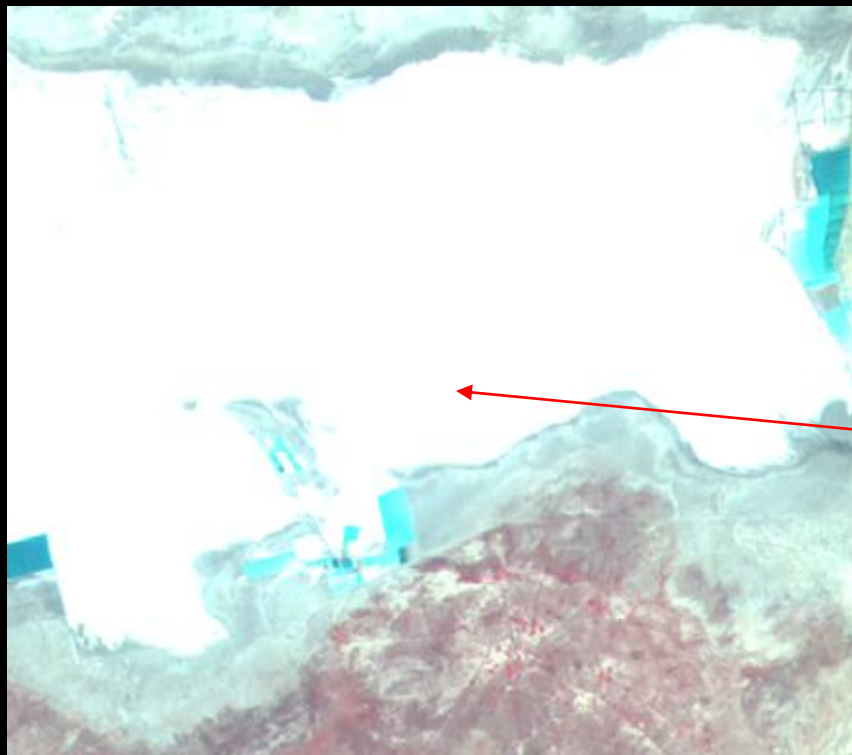
Identified Radiometric Sites



Site name:Lanela

Feature	Saline Soil
Location	27.04E ,70.81N
Average reflectance	0.44
Area	3 sq. km

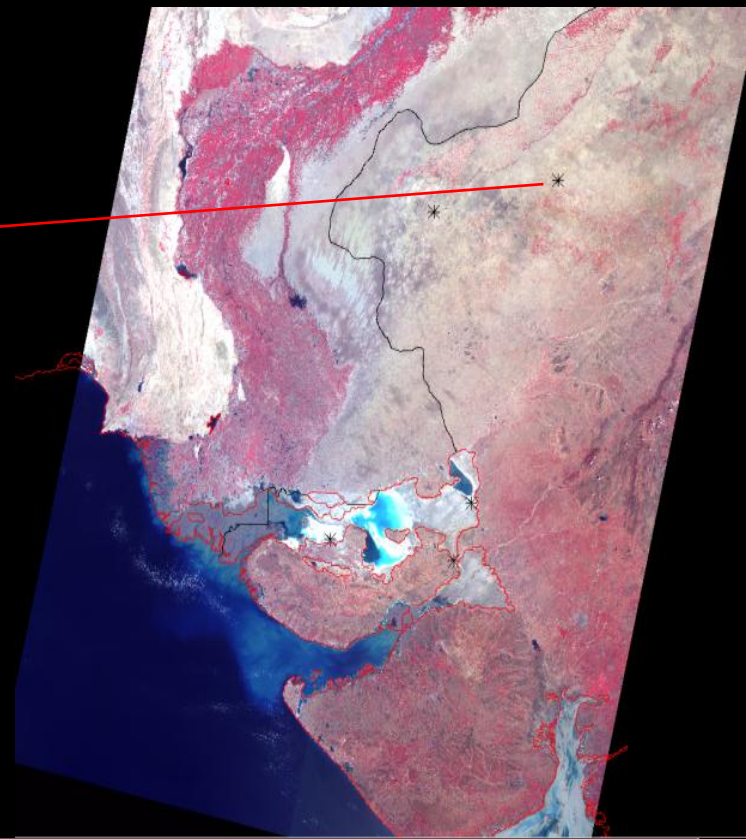
Identified Radiometric Sites



Site name:Dhordo

Feature	Salt bed
Location	23.82E ,69.51N
Average reflectance	0.55
Area	25 sq.km

Identified Radiometric Sites



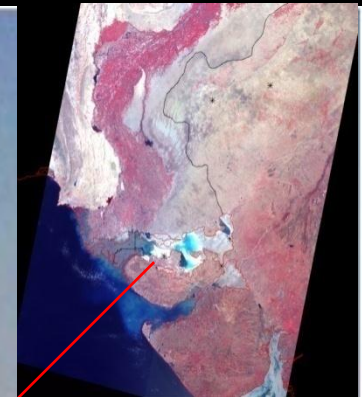
Site name:Bap

Feature	Saline soil
Location	27.33E ,72.39N
Average reflectance	0.35
Area	3 sq. km

Welcome to Desert festival (Dhordo)



Ground visits (Dhordo)



... but not before...!!



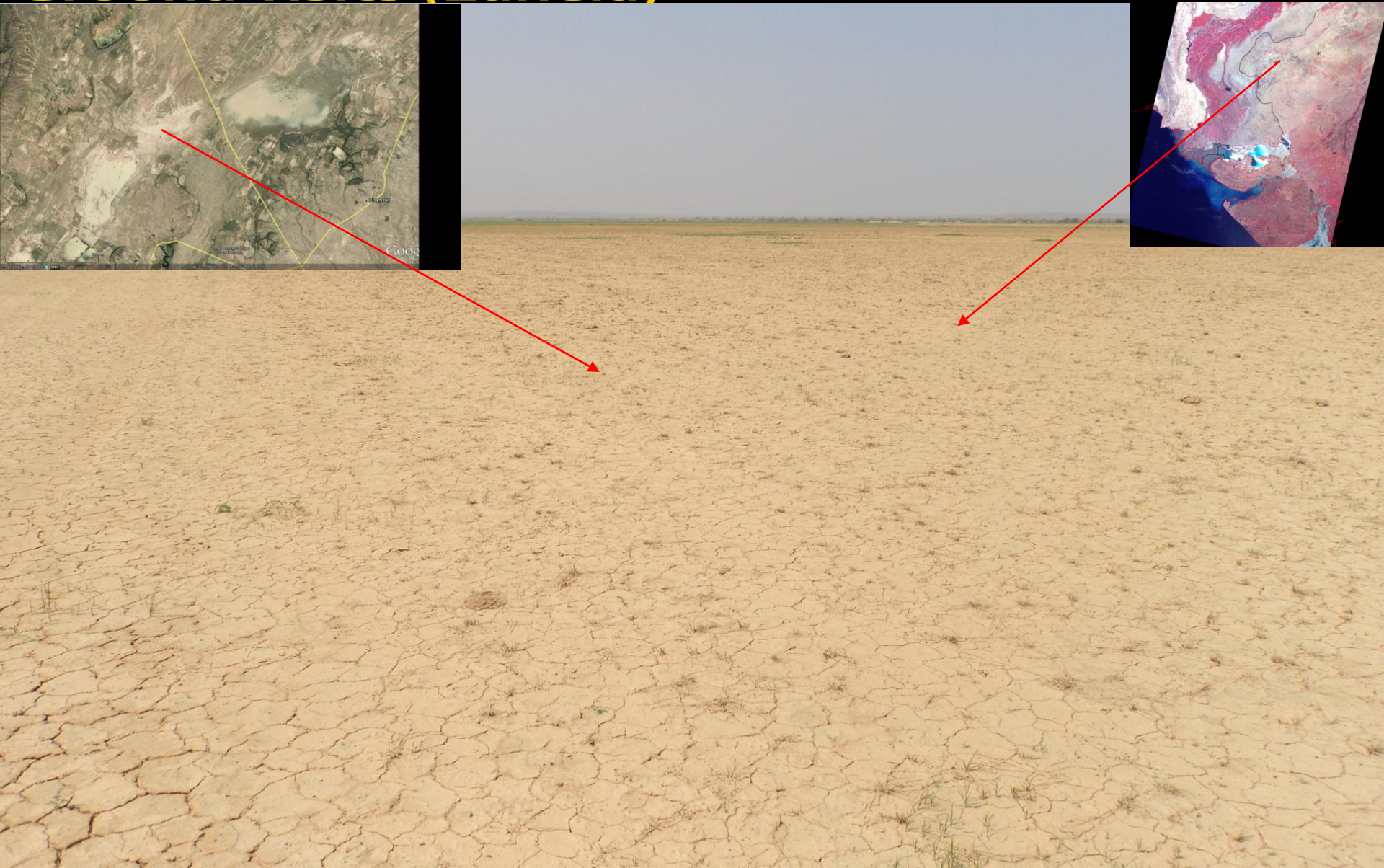
Ground visits (Bap: Sampling layout markers)



Jaisalmer: The golden city, on the way to Lanela



Ground visits (Lanela)



Evolution of Ground data sampling strategy

Sampling - Strategy

Open Distributed Homogeneous Area in kms
(walking straight at certain interval along with the reference at each point ; varying sample counts)



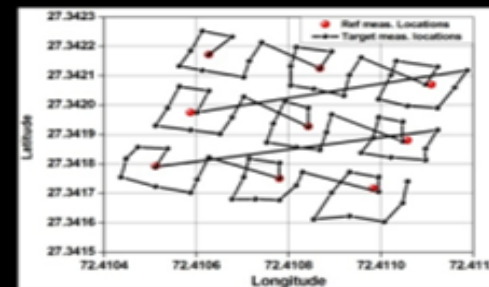
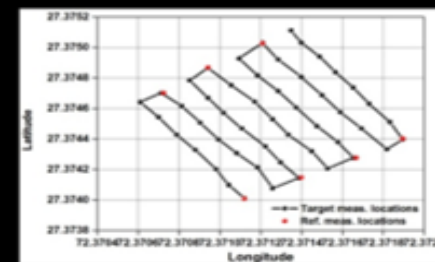
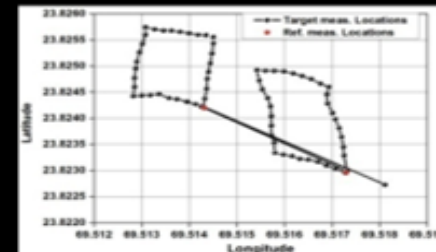
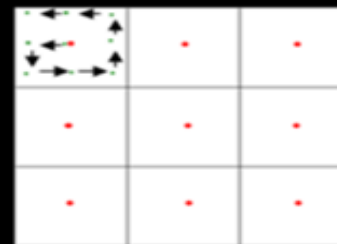
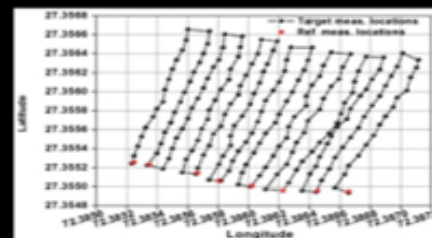
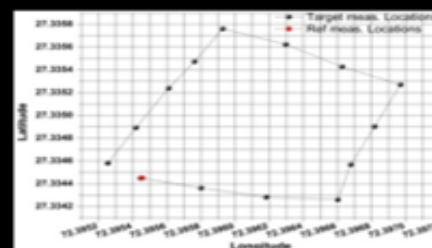
Distributed Homogeneous Area in closed loops
(walking straight at certain interval along with the reference at some fixed point)



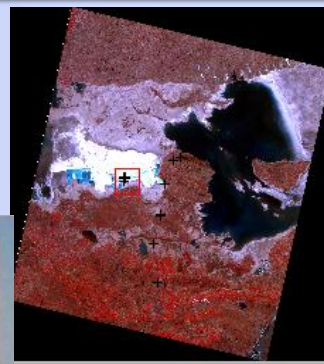
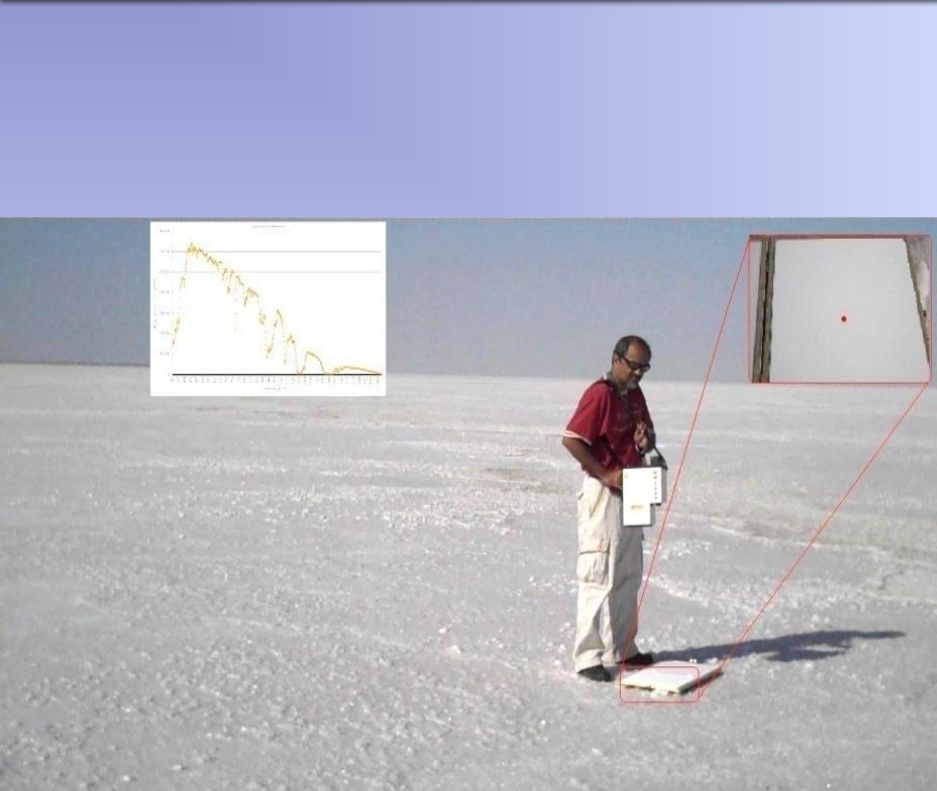
Limited Pixels of Liss-3 with Reference kept at one end (alignment using Leica Laser)



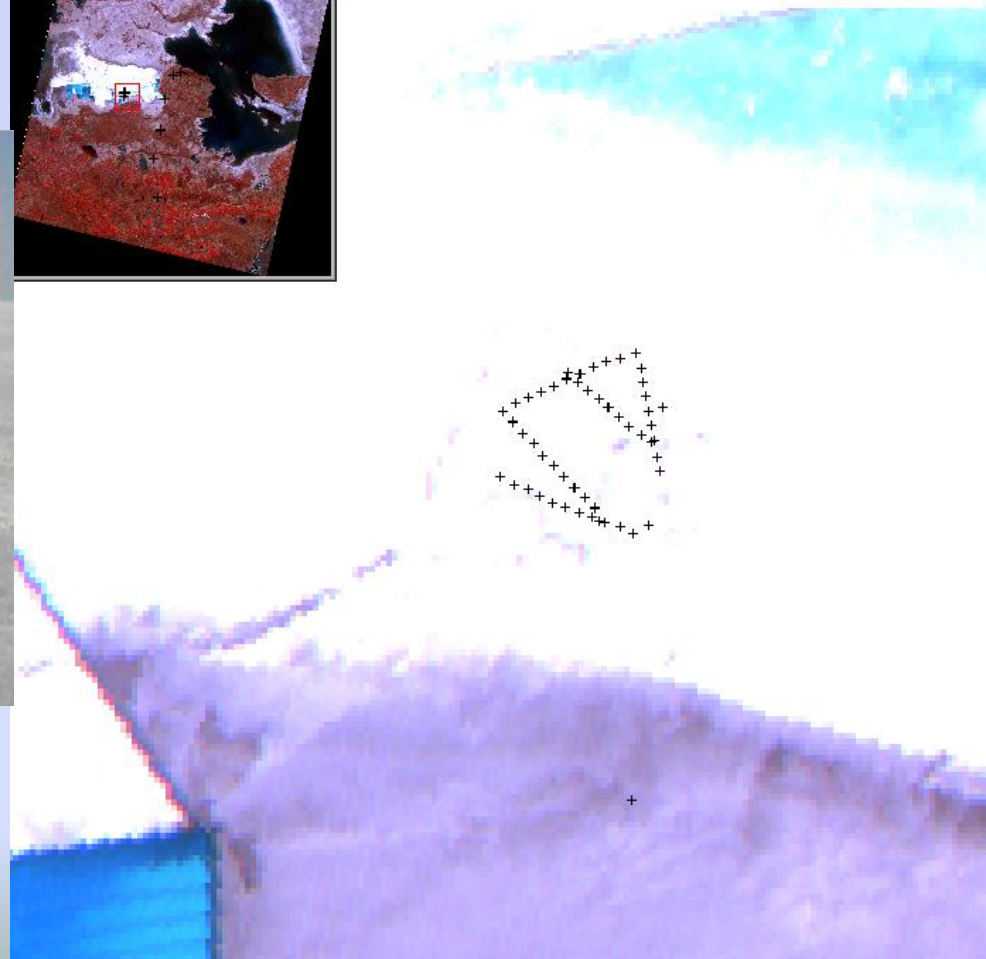
3 x 3 Pixel Strategy. Total 81 points with 9 points lying within each pixel and keeping the reference at the center (site marked using stones for ease of multiple data sets)



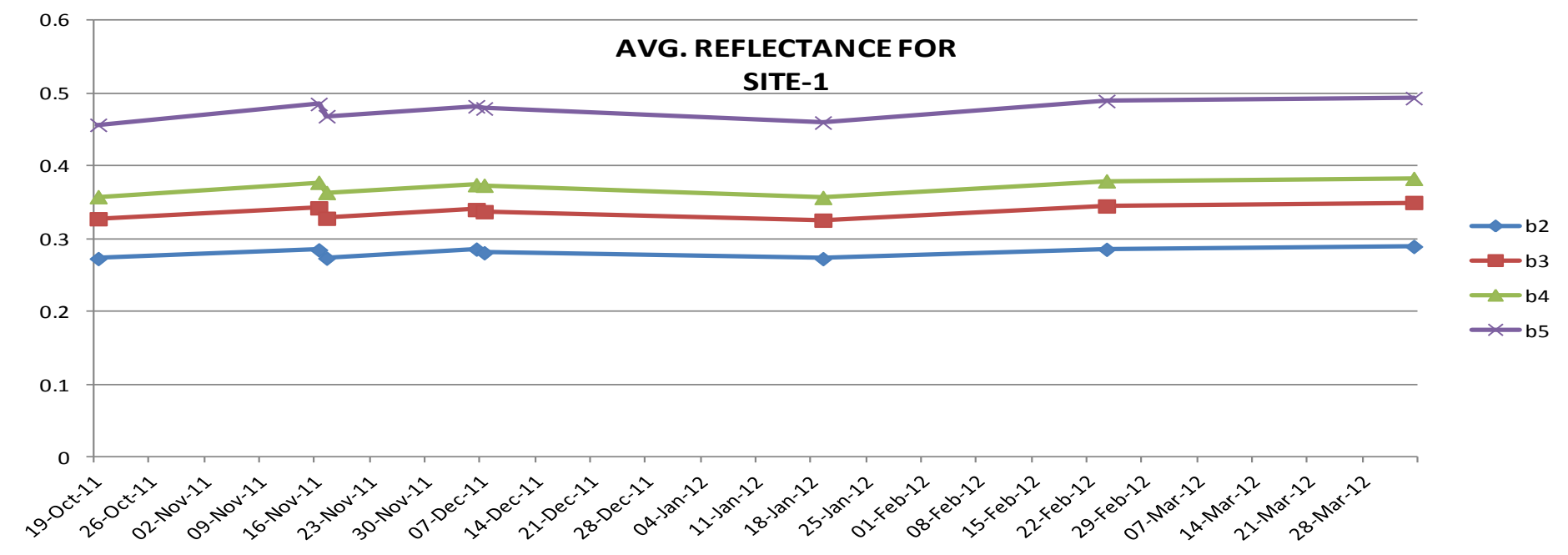
Ground measurements located on LiSS3 image:Dhordo



Characetrization of Radiometric property



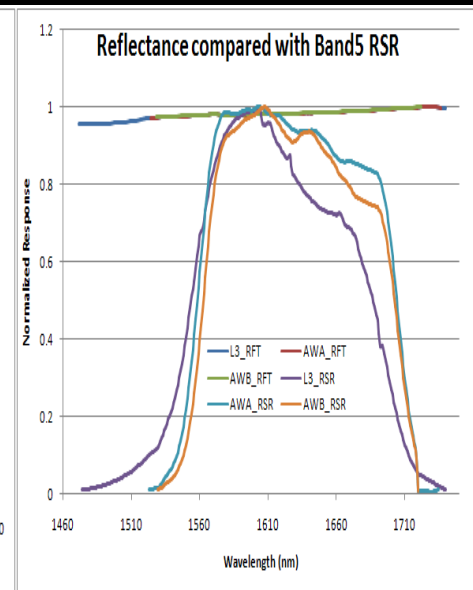
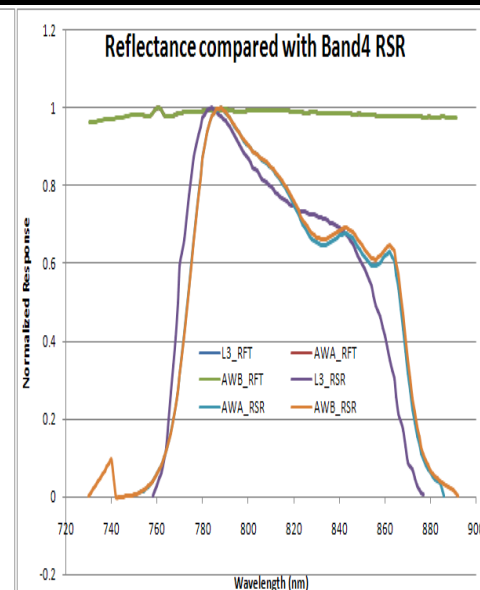
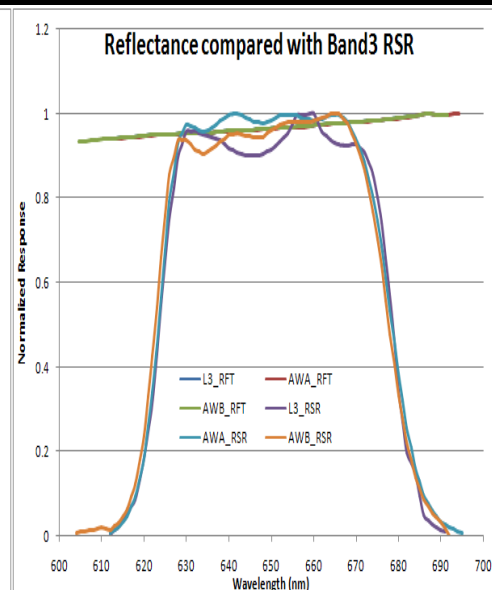
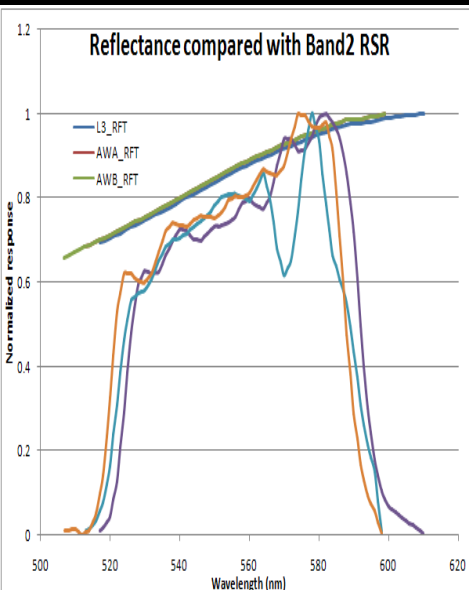
Temporal stability (Bap site)



Spectral consistency (Bap site)

Band ratios of spectral reflectance			
	B2/B5	B3/B5	B4/B5
Avg ratio	0.587	0.704	0.776
StdDev	0.00567	0.00428	0.00418

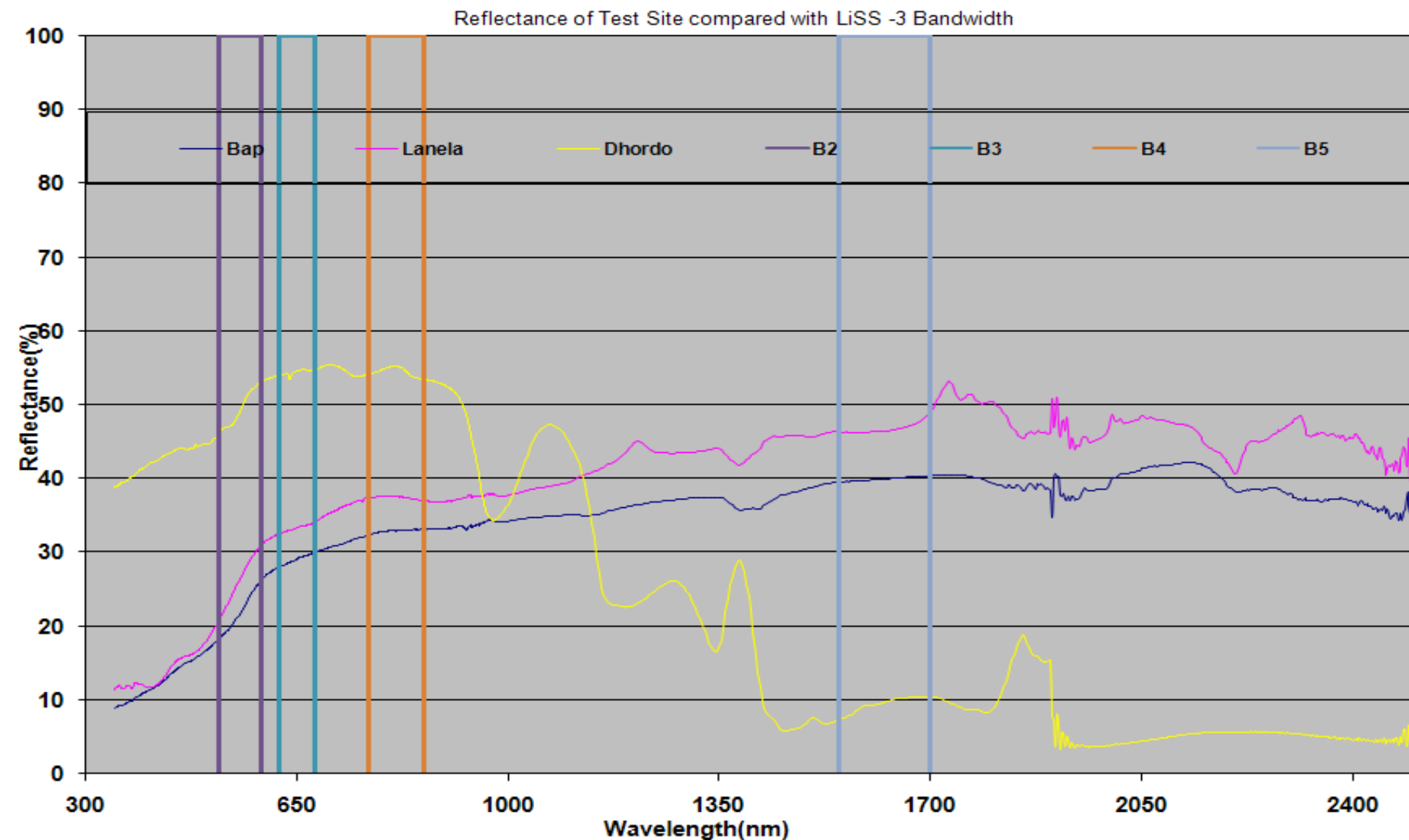
Lanala reflectance and LISS3 RSR



Temporal stability of Lanala Site (Sep-11 to Mar-12)

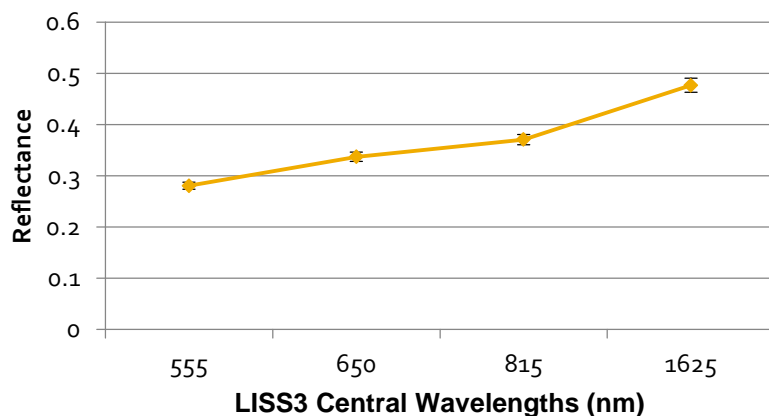
	B2	B3	B4	B5
Avg Reflectance	0.348	0.413	0.454	0.551
StdDev	0.0065	0.0099	0.0087	0.0083

Comparison of site reflectance and LiSS3 bands

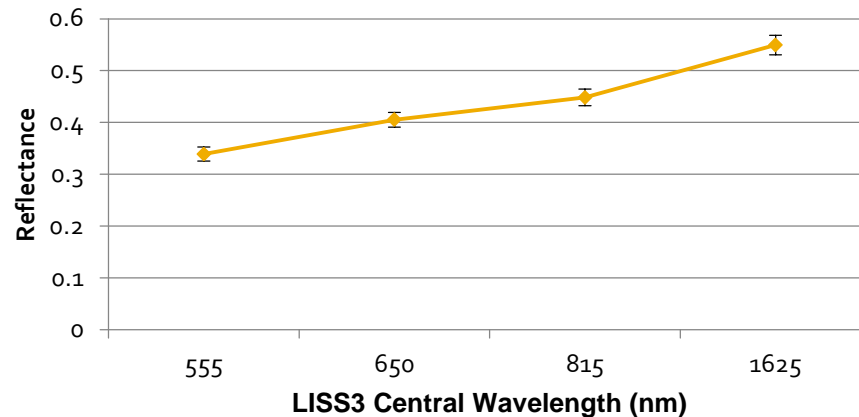


Spectral Reflectance of identified Sites for LiSS3 bands

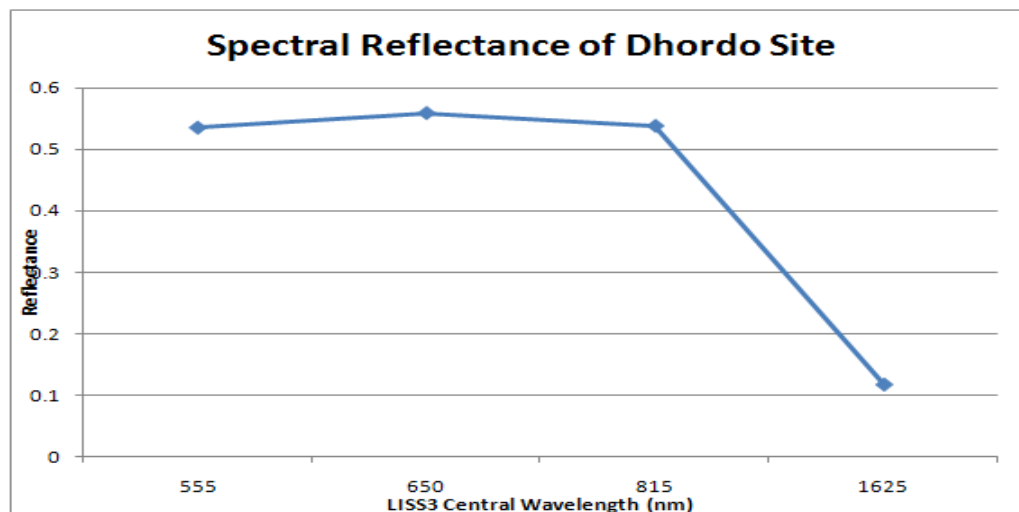
Average Spectral Reflectance of Bap site



Average Spectral Reflectance of Lanela site



Spectral Reflectance of Dhordo Site



Summary of site characteristics

- Approachability: All three sites are connected by state highway
- Reflectance: The average reflectance of all three sites is above 0.3
- Clear Days: All the sites fall under arid region of western India and hence provide ample opportunity for calibration exercise

Summary of site characteristics

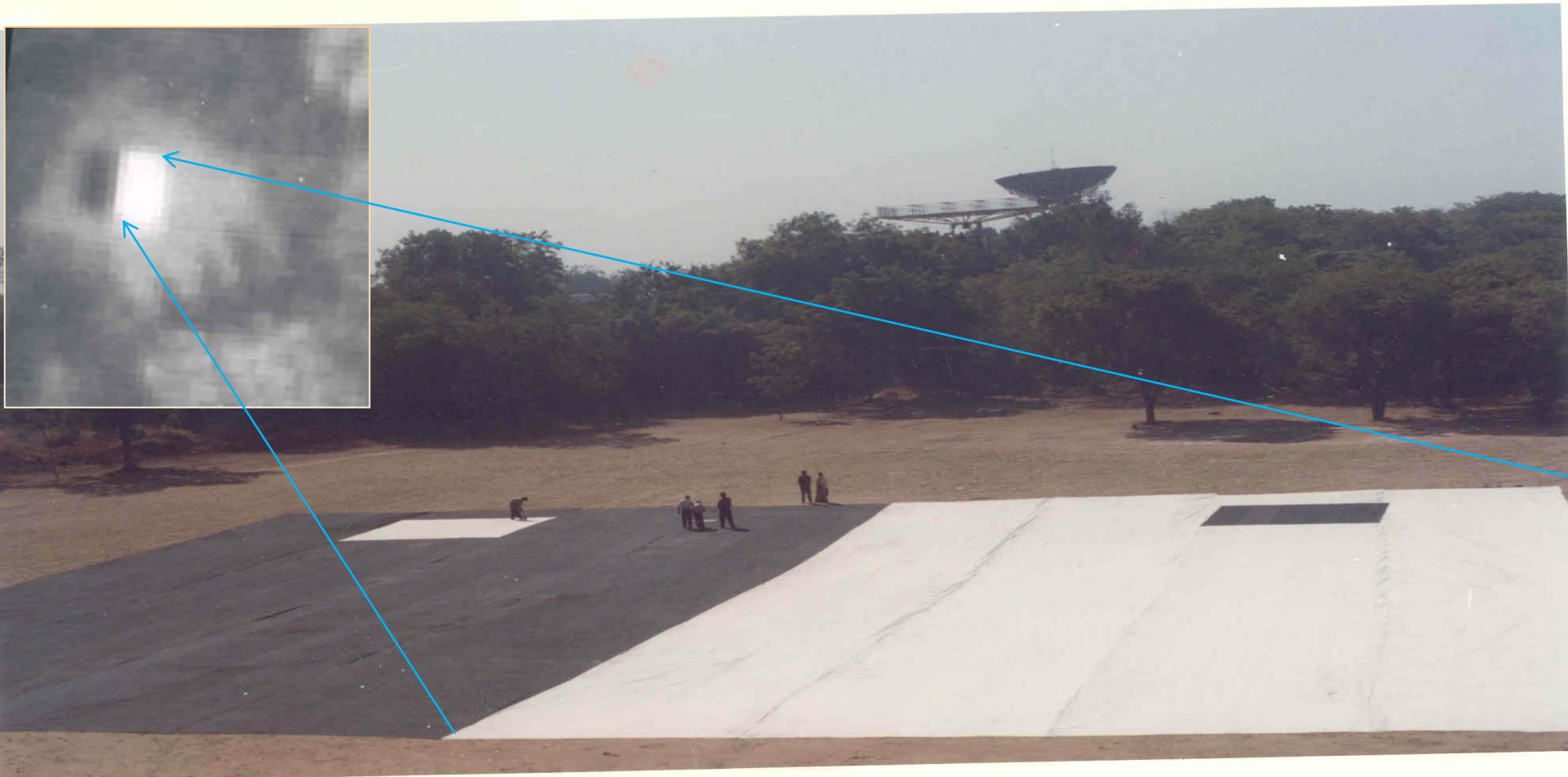
- The sites are either salt bed or desert sand- in line with '*prime candidate earth target type*'
- Flat surface Reflectance within LISS3 band RSR
- Temporal stability $<3\%$ over measured region
- The site at Lanala has a Met station in less than ten km distance

Presentation overview

- Identification and Characterization of radiometric sites for medium resolution sensors of Optical missions like Resourcesat-2
- ✓ **Tryst with artificial targets**
- Lunar calibration (Lun-cal)
- Inter-sensor cross calibration (X-cal)

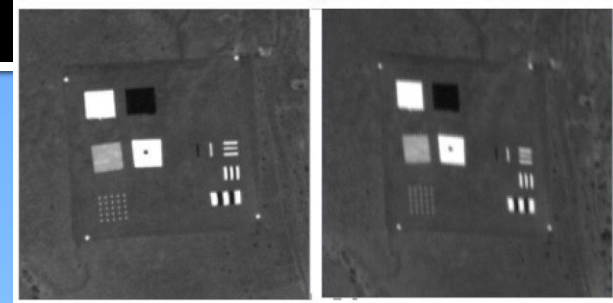
Tryst with Artificial Target: Edge formation

(inset shows the acquired image)



Tryst with Artificial Target: Point Spread Function

(inset shows the acquired image from Cartosat-1)

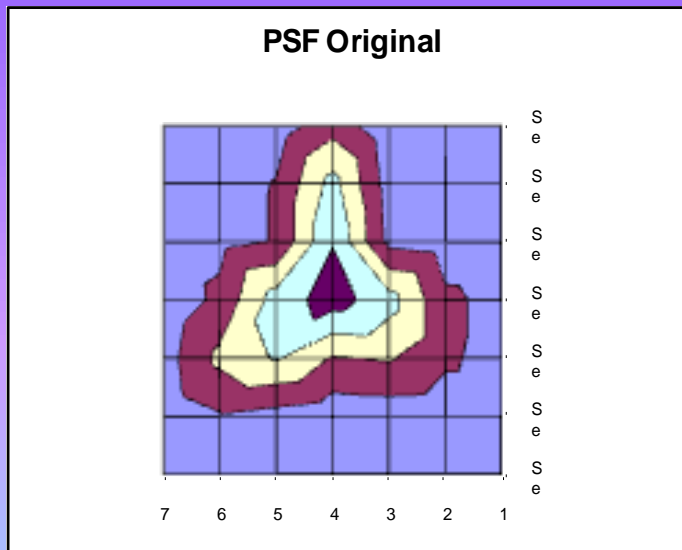


Matrix of point targets for Point Spread computation

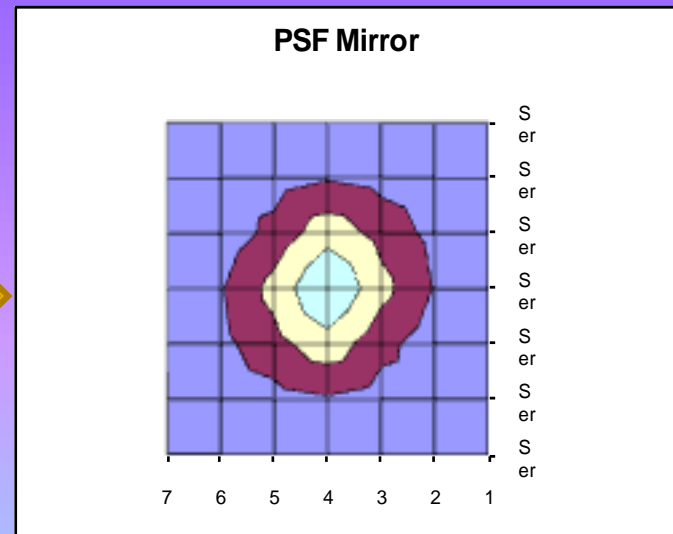
Use of Convex mirror as point targets



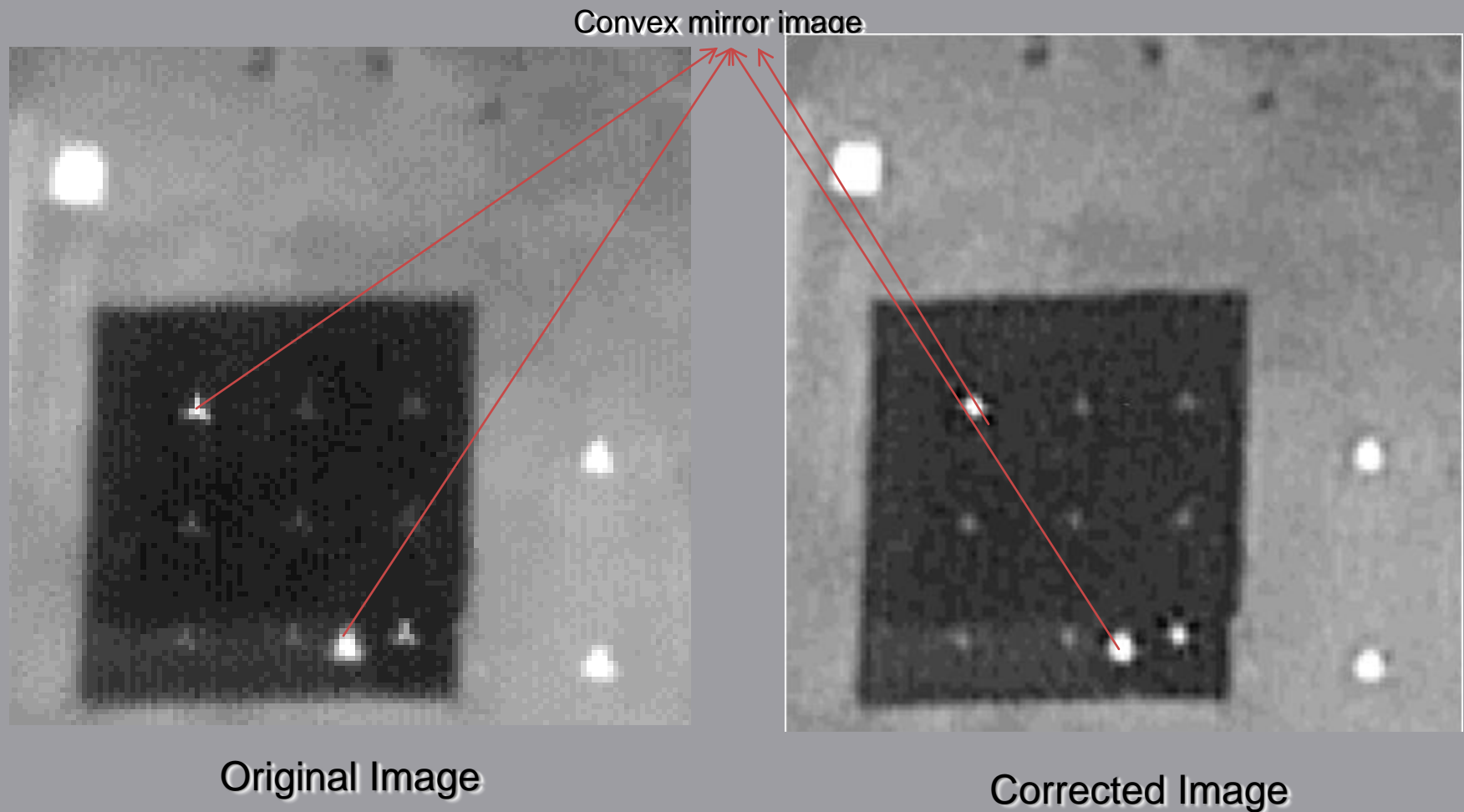
Convex mirror results (Cartosat-2A)



Correction



Result of PSF correction



Presentation overview

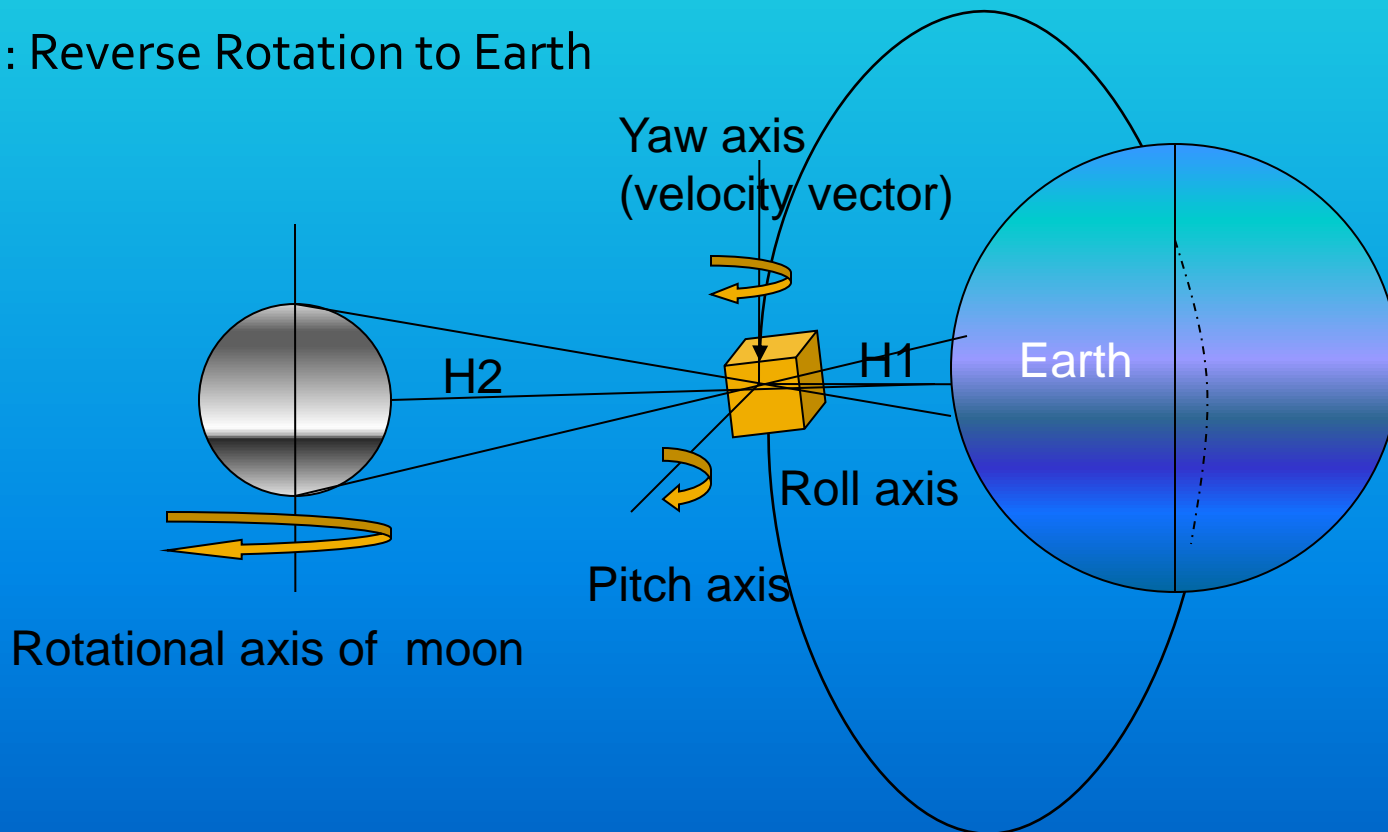
- Identification and Characterization of radiometric sites through in-situ measurements
- Tryst with artificial targets
- ✓ **Lunar calibration (Lun-cal)**
- Inter-sensor cross calibration (X-cal)

Lunar Calibration of Ocean Color Monitor-2 (OCM-2) onboard Oceansat-2

- Oceansat-2 carries three sensors –OCM-2; OSCAT; ROSA
- Challenge due to co-passengers
- Lunar imaging carried out on
 - Jul 26, 2010 – Three segments of CCD array
 - Nov 11, 2011
 - Aug 01, 2012

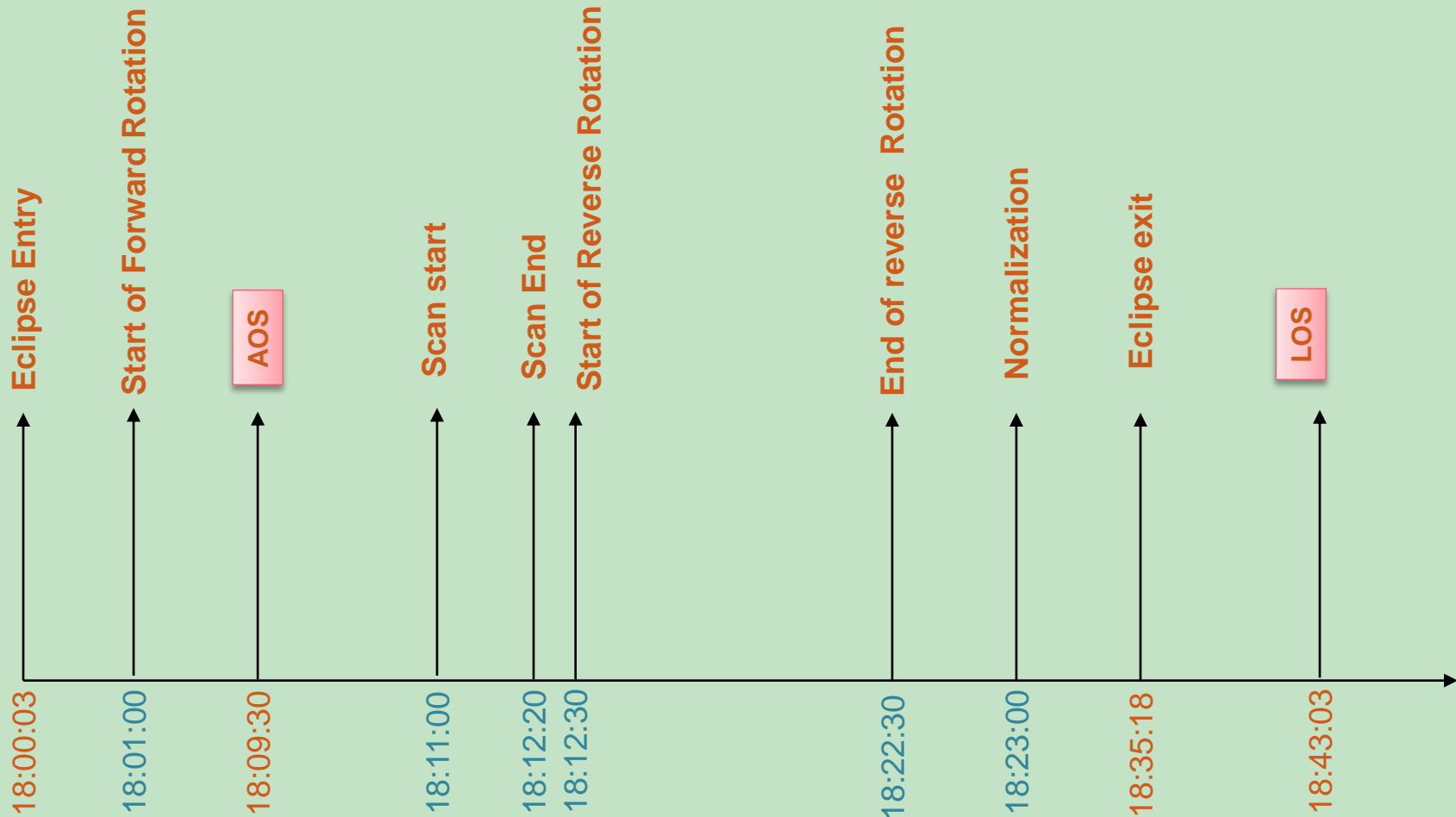
Imaging the moon

- Step1 : Target the Center CCD to a point 2.0deg (Pitch bias 2.0 deg) Above the Moon center
- Step2 : Provide Pitch Scan Rate of -0.05 d/s
- Step 3 : Reverse Rotation to Earth



Time Line Diagram of moon acquisition

Ref: email communication from R.Suresh,ISAC



Jul 26, 2010: Three segments of CCD array



Left

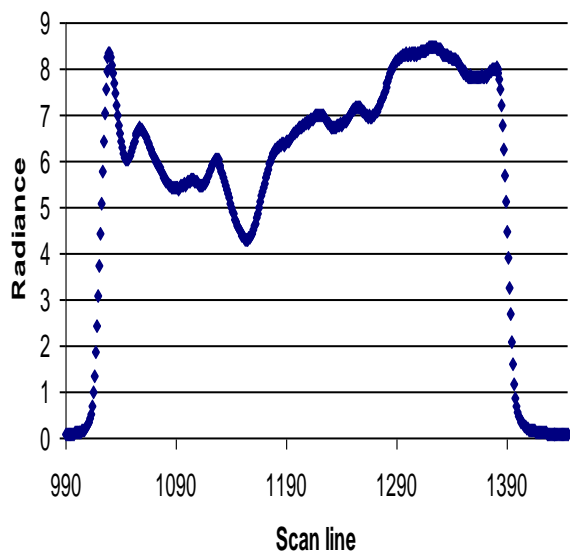


Center

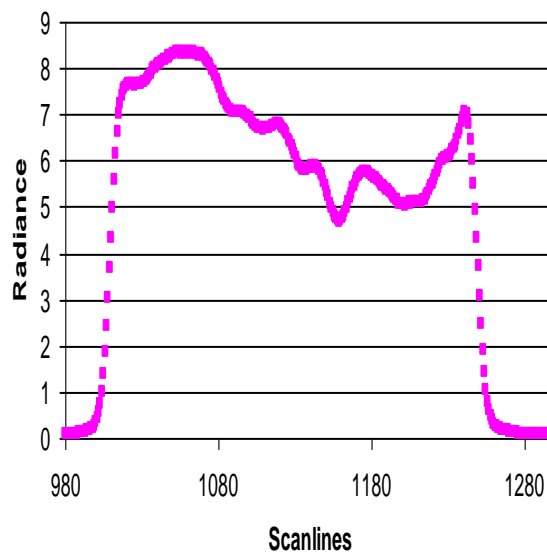


Right

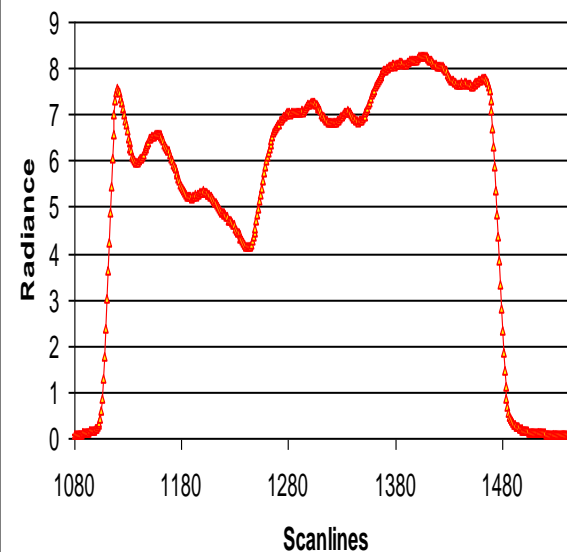
Left Moon Length = 455 scans



Central Moon Length = 320 scans



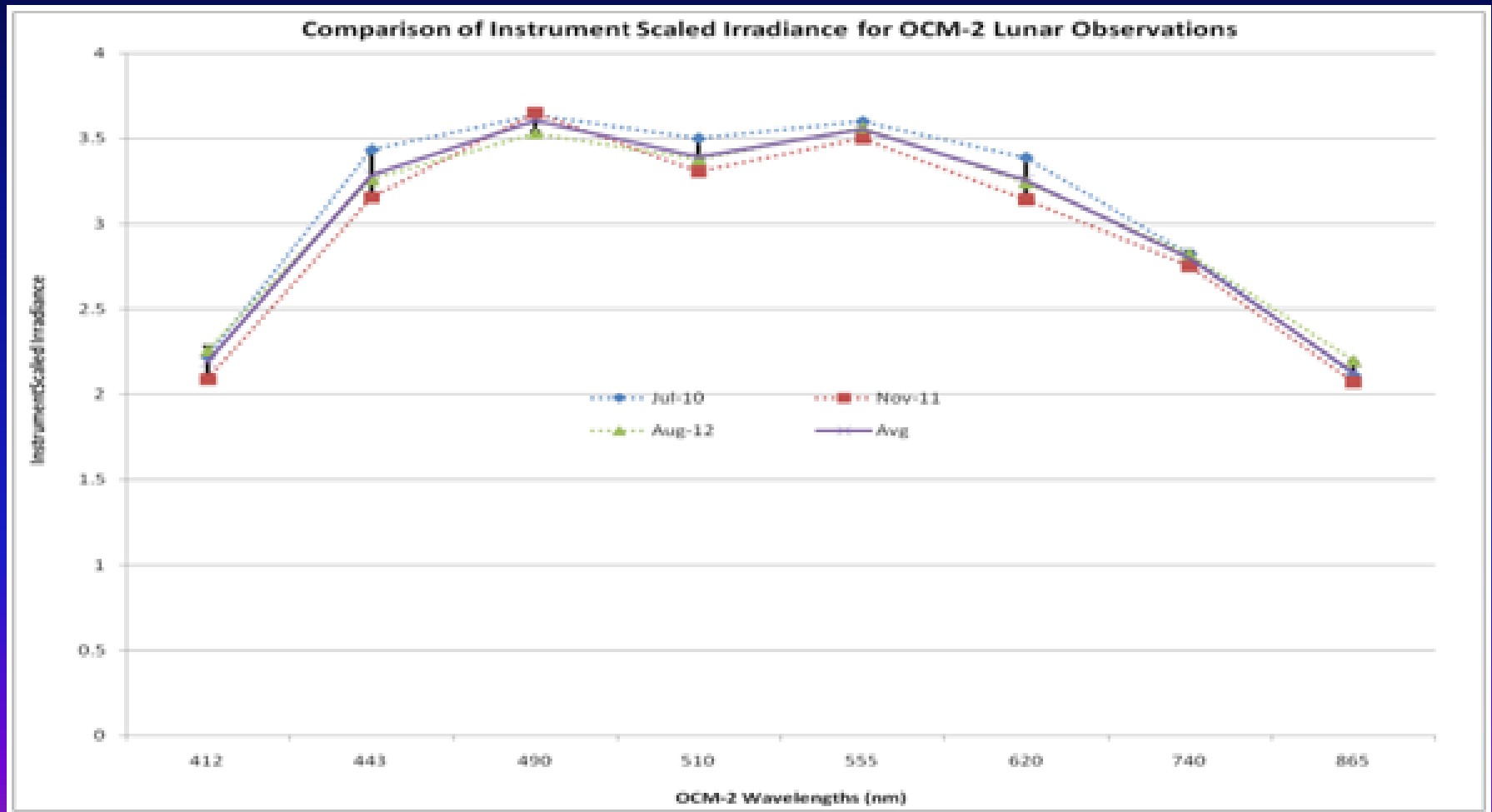
Right Moon Length = 470 scans



Radiance in ($\text{milli W cm}^{-2} \text{ sr}^{-1} \text{ micro m}$) units

CEOS Joint meeting of WGCV-35 24-28 Sep 2012 Hyderabad India

Comparison of Lunar Irradiance for 26Jul2010, 11Nov2011 and 1Aug2012 acquisitions



Presentation overview

- Identification and Characterization of radiometric sites through in-situ measurements
- Tryst with artificial targets
- Lunar calibration (Lun-cal)
- ✓ **Inter-sensor cross calibration (X-cal)**

Cross calibration between AWiFS and LiSS3 sensors of Resourcesat-2

- The Resourcesat-2 carries three sensors

- AWiFS:- 56m resolution
- LiSS3:- 23.5m resolution
- LiSS4:- 5.8m resolution

giving a unique 3-tier simultaneous imaging capability

- All three sensors have identical spectral but different spatial resolutions
- AWiFS has 12-bit and L3/L4 has 10-bit quantization

3-tier imaging (respective spatial resolutions)

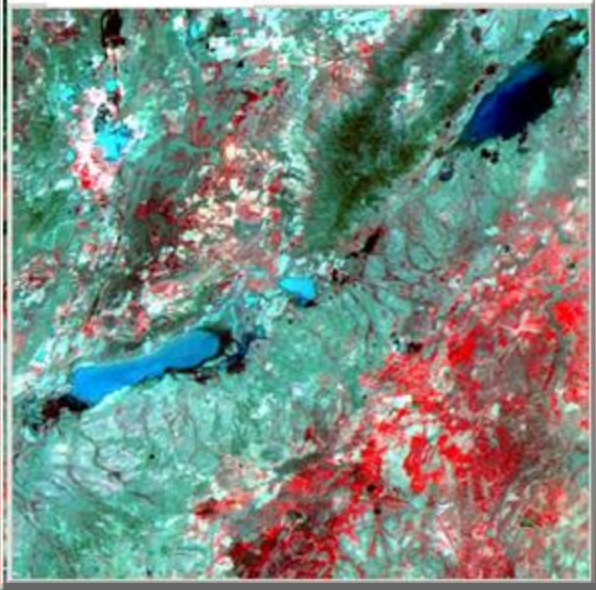
Resourcesat-2 LISS4 Multi spectral
5.8m



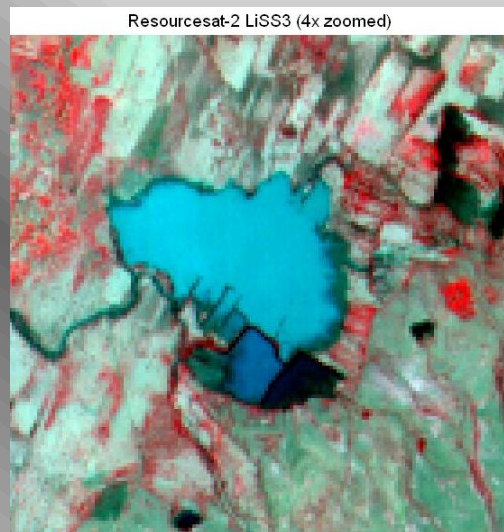
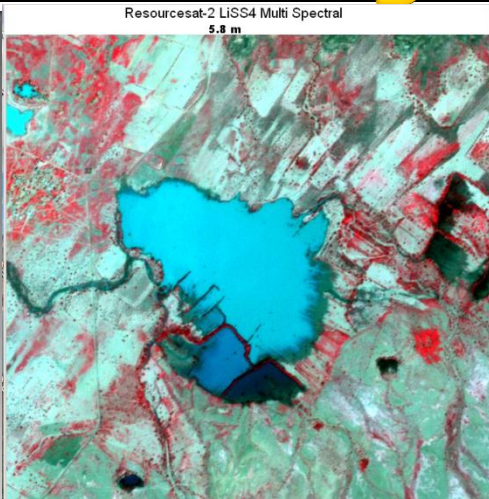
Resourcesat-2 LiSS3
23.5 m



Resourcesat-2 AWiFS subscene-B
56m



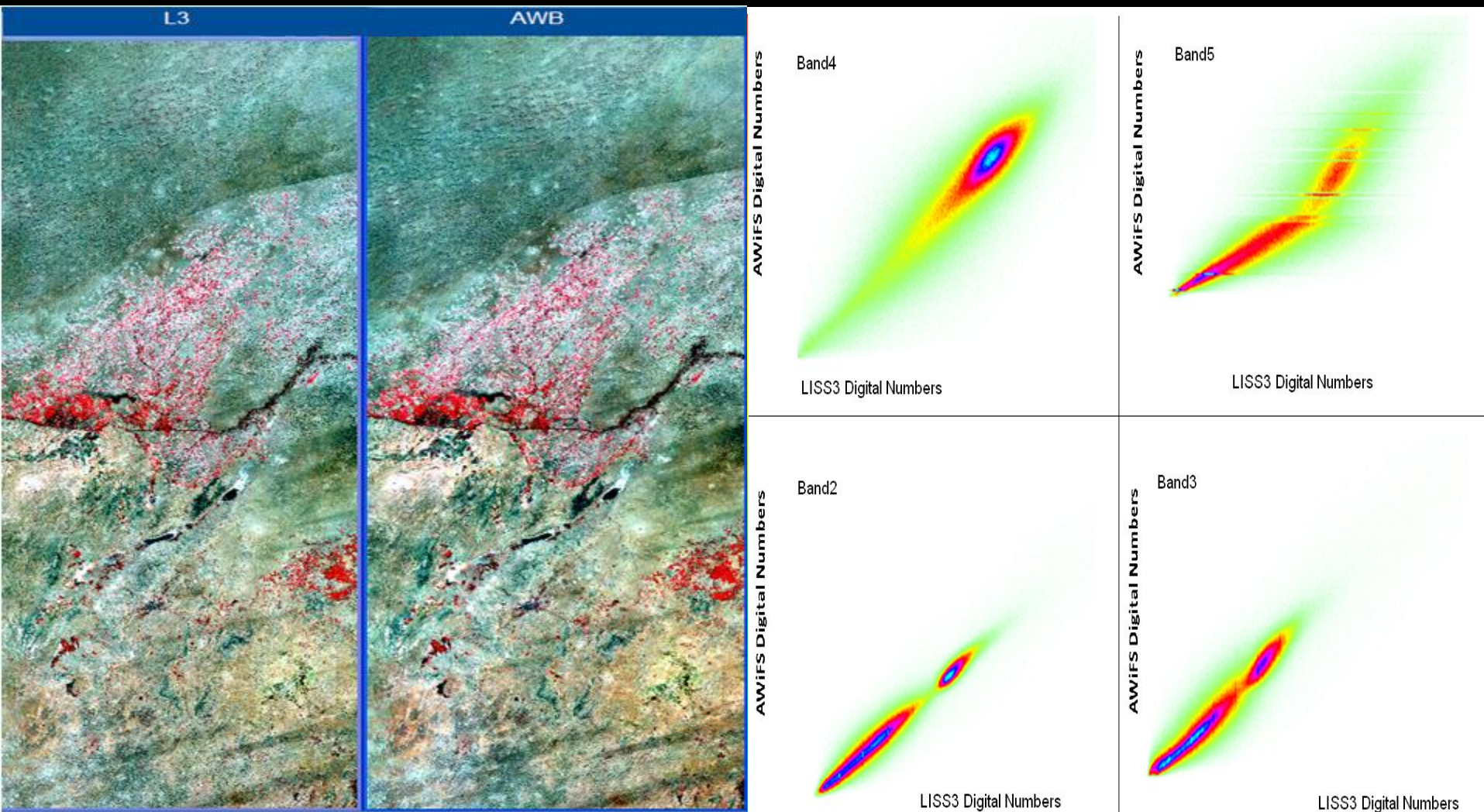
3-tier imaging



Methodology (AW vs. L3 X-calibration)

- Geo-reference AW and LiSS3 Images
- Extract common area
- Resample LiSS3 image (23.5m) to AW resolution (56m) using pixel aggregate method
- Generate Scatter histogram between two sensors for uniform areas

Common region of interest and scatterplot



Yogdeep

B Kartikeyan

V R Bhavsar



S S Srivastava



THANKS FOR YOUR KIND ATTENTION

Maneesha

