ISRO Agency Report

Indian CAL-VAL Activities

- *Present and Future*

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Feb. 20, 2014
Frascati, Italy
WGCV – 37 Meeting

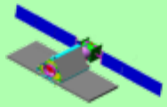
Indian Earth Observation Satellites

- One of the largest constellations
- Provides remote sensing data in a variety of spatial, spectral and temporal resolutions
- Both Optical and Microwave

Land & Water

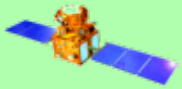
2009
RISAT-2
X-SAR

2012
RISAT-1
C-SAR

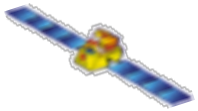


2007/ 2008/ 2010
CARTOSAT-2/2A/2B
PAN

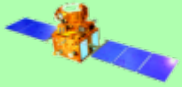
2011
RESOURCESAT-2
LISS 3; LISS 4; AWiFS



2005
CARTOSAT-1
Stereo PAN, F/A



2003
RESOURCESAT-1
LISS 3; LISS 4; AWiFS

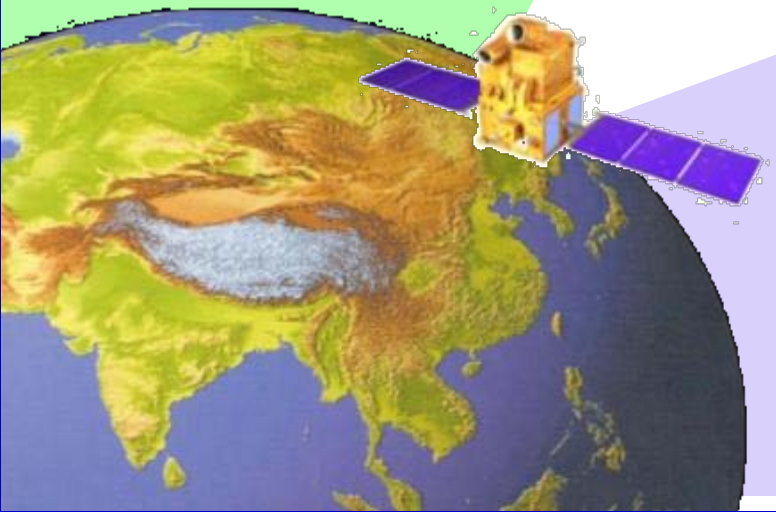


2008
IMS-1
MX-T; HySI

2001
Step & Stare PAN

Cartographic

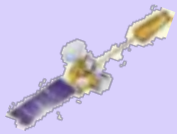
Ocean & Atmosphere



2009
OCEANSAT-2
OCM , SCAT
ROSA

2013
INSAT-3D
IMAGER, SOUNDER

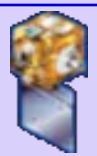
2003
INSAT- 3A
VHRR, CCD



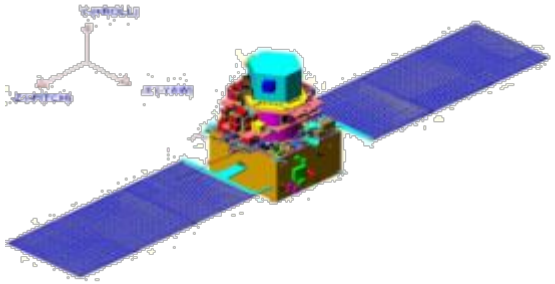
2013
SARAL
ALTIKA, ARGOS

2011
Megha-Tropiques
MADRAS, SAPHIR, SCaRaB

2002
KALPANA-1
VHRR



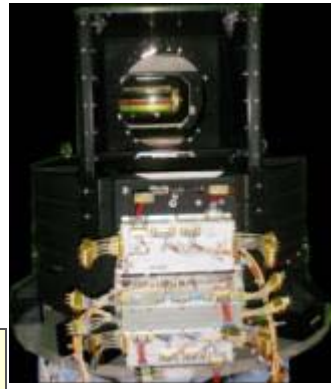
Resourcesat-2 (2011)



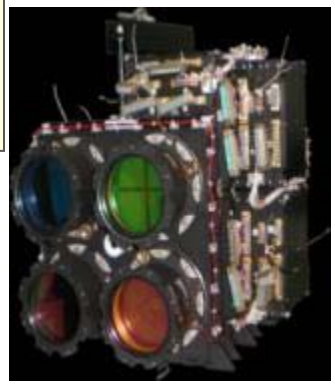
- LISS-4 MX camera: 5.8m Resolution and 70 Km swath
- LISS-3: 23.5m Resolution and 141 Km Swath
- AWiFS: 56m Resolution and 740km Swath
- Repetitivity: 5 days (AWiFS) to 24 days (LISS 3) &
- Revisit: 5 days (LISS 4) with tilting 26 deg tilt

SENSORS	SPECTRAL BANDS	Ground Res. (m)	Swath (km)	Rad. Res. (bits)	Revisit cycle (days)
LISS III VNIR/SWIR	B2 B3 B4 B5	23.5	141	10	24
LISS-IV MX VNIR	B2 B3 B4	5.8	70	10	24
AWiFS VNIR/SWIR	B2 B3 B4 B5	56	740	12	5

Linear Imaging Self Scanner (LISS-4)



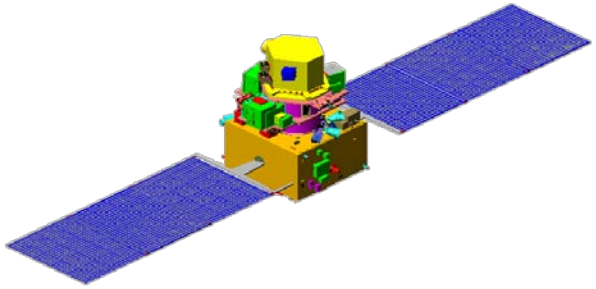
Linear Imaging Self Scanner (LISS-3)



Advanced Wide Field Sensor (AWiFS)

RESOURCESAT-2A

LAUNCH: 2015-16



Major Objectives

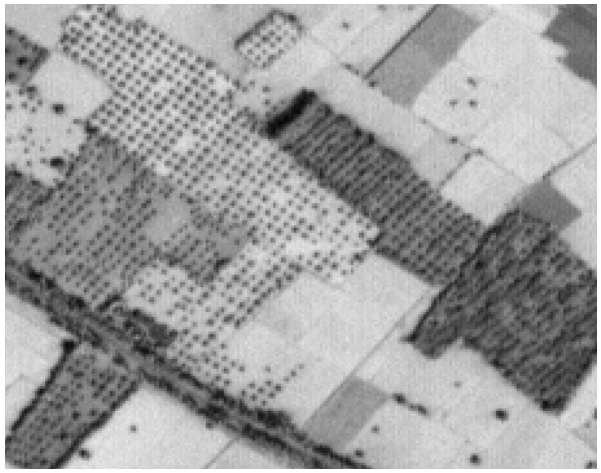
- **To provide continuity of on-going services of Resourecesat-2 and ensure in-orbit redundancy of the satellite**
- **Increased frequency of observations in tandem with Resourecesat-2 during overlap period**
- **To explore newer application areas in Land and Water Resources monitoring & management**

SENSORS	SPECTRAL BANDS	Ground Resolution (meters)	Swath (km)	Radiometric Resolution (bits)	Revisit Cycle (days)
LISS III VNIR/SWIR	B2 B3 B4 B5	23.5	141	10	24
LISS-IV MX VNIR	B2 B3 B4	5.8	70	10	24
AWiFS VNIR/SWIR	B2 B3 B4 B5	56	740	12	5

Cartosat-1 and 2 (2005, 2007)

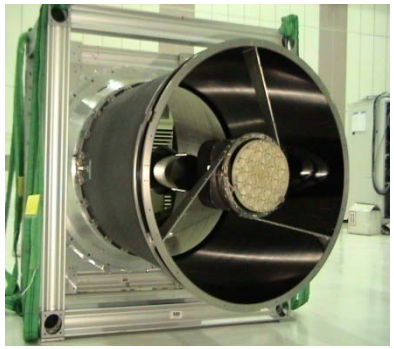
Cartosat-1

- 2.5 m resolution, 30 km Swath
- Stereo mission; +26° / -5° forward/ Aft view
- Revisit : 5 days
- Along Track Stereo viewing - first of its kind in the world



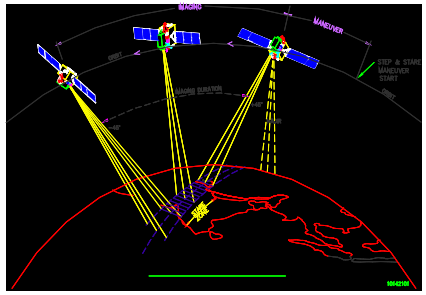
Cartosat-2

- Swath (km) : 10
- SNR : ≥ 180
- IGFOV (m) : 0 .8
- SWR (%) : ≥ 10



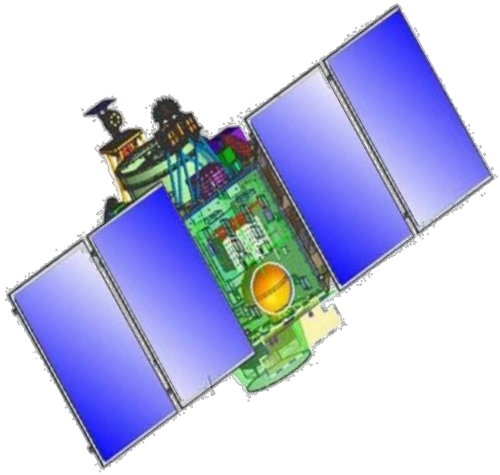
Cartosat-2 Data Products - Handling of unique imaging modes

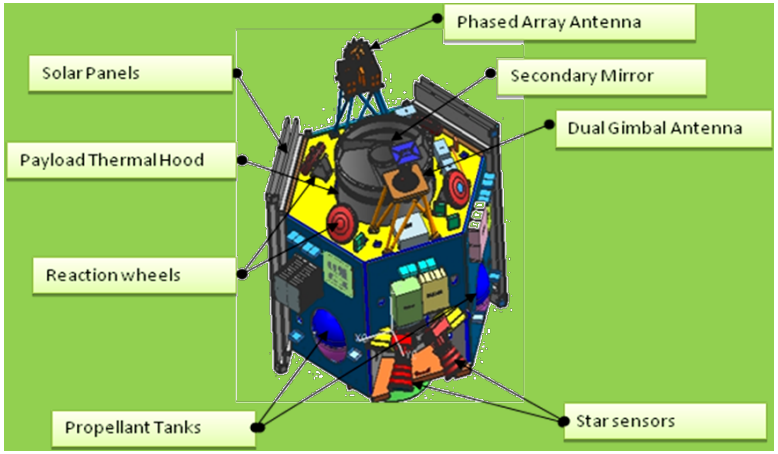
- *paint brush*
- *multi-view in step and stare*
- *spot scenes*



CARTOSAT-2C

LAUNCH: 2015-16





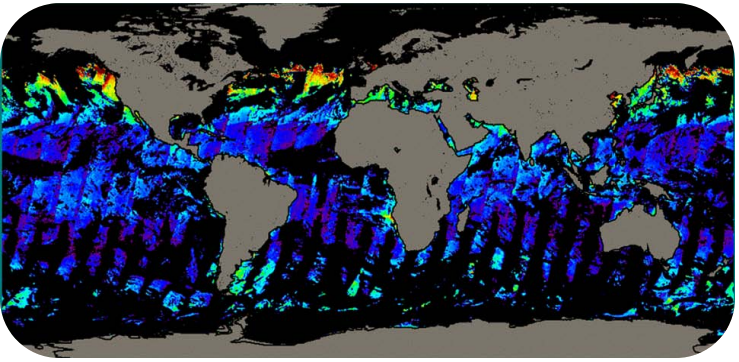
- Panchromatic camera; 0.65 m
- Multispectral: 2 m
- No. of Bands: 4
- Swath : 10 km
- Radiometric Resolution: 11 bit
- Steering up to ±26°
- Altitude: 500 km
- Solid State Recorder: 600 Gb
- Local time: 0930 hrs
- Revisit : 5 days

Major Objectives

- To provide continuity of on-going data services of Cartosat-2
- To design and develop a highly agile and advanced satellite with high spatial resolution both in panchromatic and multi-spectral bands
- To meet the increasing user demands for cartographic and cadastral level applications with improved revisit capability in tandem with Cartosat-2 missions.

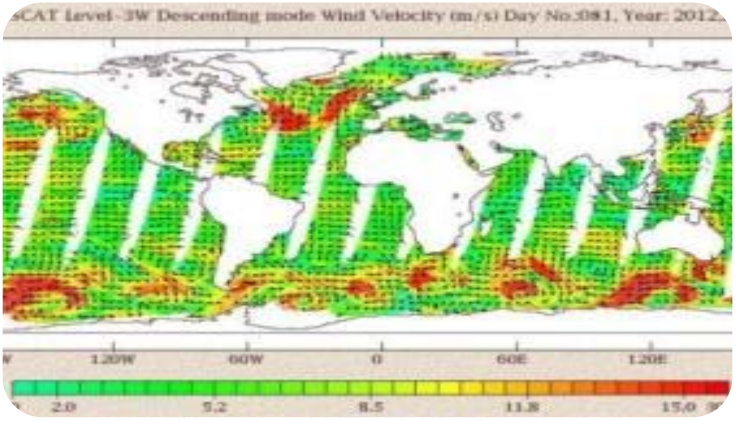
Oceansat-2 (2009)

A global mission, providing continuity of ocean color data and wind vector in addition characterization of lower atmosphere and ionosphere from ROSA payload.



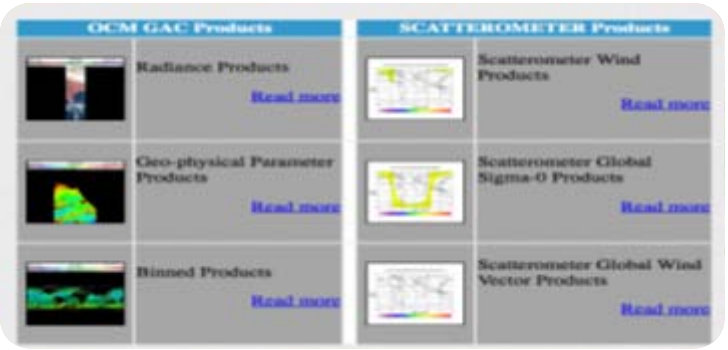
Global data acquisition of Ocean colour

- High Resolution Data - NRSC and INCOIS
- 1km resolution global products through NRSC Website
- Global Chlorophyll, Aerosol Optical Depth through NRSC Website
- Regional/Global NDVI, VF, Albedo products



Scatterometer Wind Products

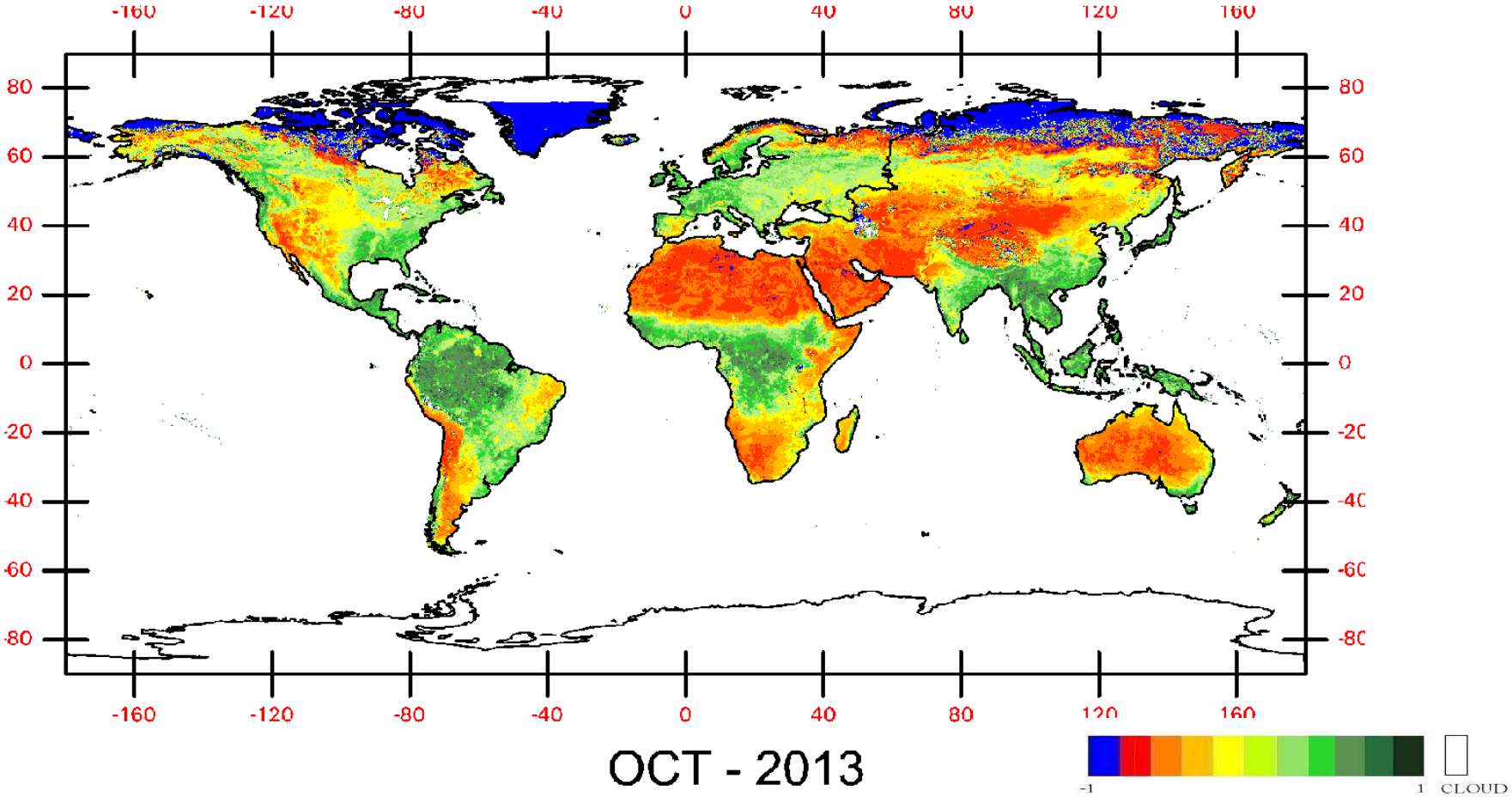
- Reception Station at Svalbard
- Real time transfer and processing
- Uploading to Web within 3 hrs through EUMETCAST
- 1.72 Lakhs data are downloaded from NRSC Website



Data Dissemination Mechanism

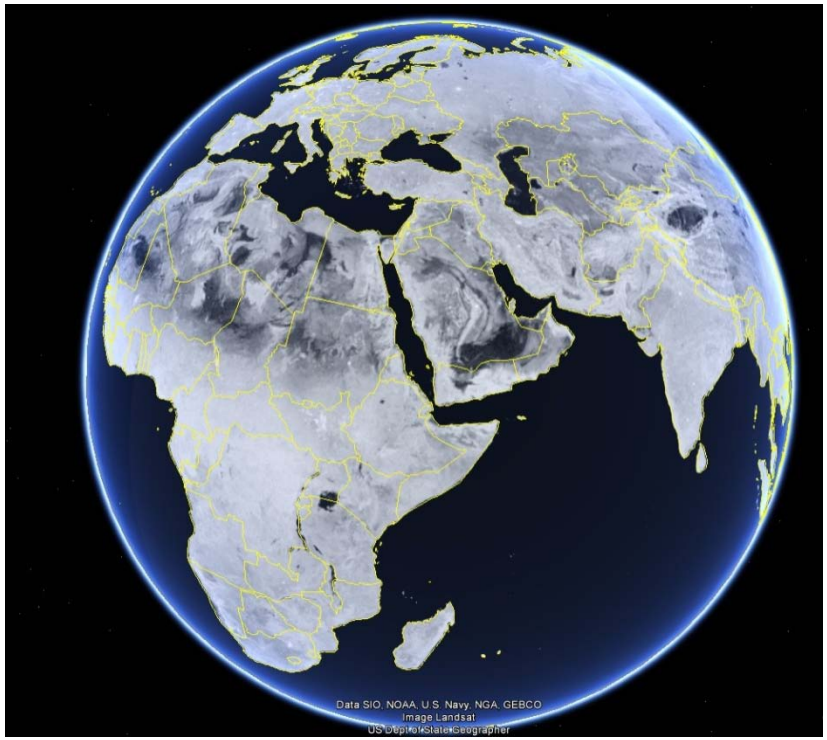
- Established Ground station at INCOIS
- Ground station at Bharti, Antarctica is commissioned.
- EUMETCAST, NRSC Website for data and products

Global Vegetation Index Products from OCM sensor



Pixel Size: 8 km; Cycle: Monthly; Method: Max. Value Composite (to reduce cloud cover)
CC>80% with MODIS NDVI

Microwave Digital Earth from OSCAT @2.5km pixel



OSCT data draped on Google Earth

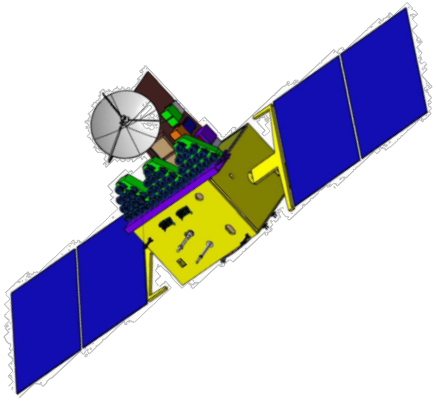
Date: Oct. 23-24, 2012

- **OSCAT scatterometer**
- **Temporal resolution 2 days.**
- **Operational frequency is 13.5 GHz.**
- **Originally developed to measure winds over the ocean from space,**
- **OSCAT data useful in a variety of Land studies including polar ice and tropical vegetation.**

- ***NASA sponsored Scatterometer Climate Record Pathfinder at Brigham Young University (courtesy: David G. Long) by SIR algorithm* available at 2.225km pixel.**
- **Datasets further processed for geometric rectification and mosaicking to realize a 3-D virtual reality land product at 2.5km after ocean regions are masked.**
- **Probably first microwave 2D-Digital Earth at this spatial/temporal resolutions available todate in public domain (nrsc website).**

OCEANSAT-3 Mission

LAUNCH: 2016-17



OCEANSAT-3 is a global mission and is configured to cover global oceans and provide continuity of ocean colour data with global wind vector and characterization of lower atmosphere and ionosphere.

Payloads:

- **An 13-band Ocean Colour Monitor (OCM) in VNIR (400-1010 nm range) with 360 m spatial resolution and 1400 km swath for ocean Colour monitoring**
- **2-band Long Wave Infra Red (LWIR) around 11 and 12 µm for Sea Surface Temperature (thermal channels) at 1080 m resolution.**
- **A Ku-Band Pencil beam SCATTEROMETER with a ground resolution of 50 km x 50 km for Continuity of wind vector data for cyclone forecasting and numerical weather modelling**

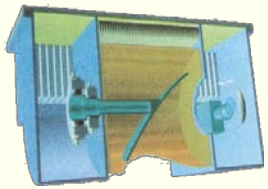
Objectives:

- **Continuity of ocean colour data with improvements to continue and enhance operational services like potential fishery zone and primary productivity.**
- **To enhance the applications by way of simultaneous Sea Surface Temperature (SST) measurements, in addition to chlorophyll, using additional thermal channels, is envisaged in this mission.**
- **Continuity of wind vector data through repeat of Scatterometer for cyclone forecasting and numerical weather modelling.**
- **The mission, in tandem with Oceansat-2 (on availability), will improve the repetivity of ocean colour measurements to every 24 hour and wind vector measurements to every 12 hour.**

Megha-Tropiques (Indo-French Mission: 2011)

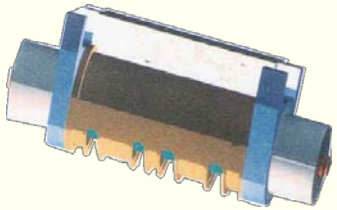
For studying water cycle and energy exchanges to better understand the life cycles of the tropical convective system. The satellite is contributing to Global Precipitation Mission (GPM)

SAPHIR



- Water vapour profile
- Six atmospheric layers upto 12 km height
- 10 km Horizontal Resolution

SCARAB



- Outgoing fluxes at TOA
- 40 km Horizontal Resolution

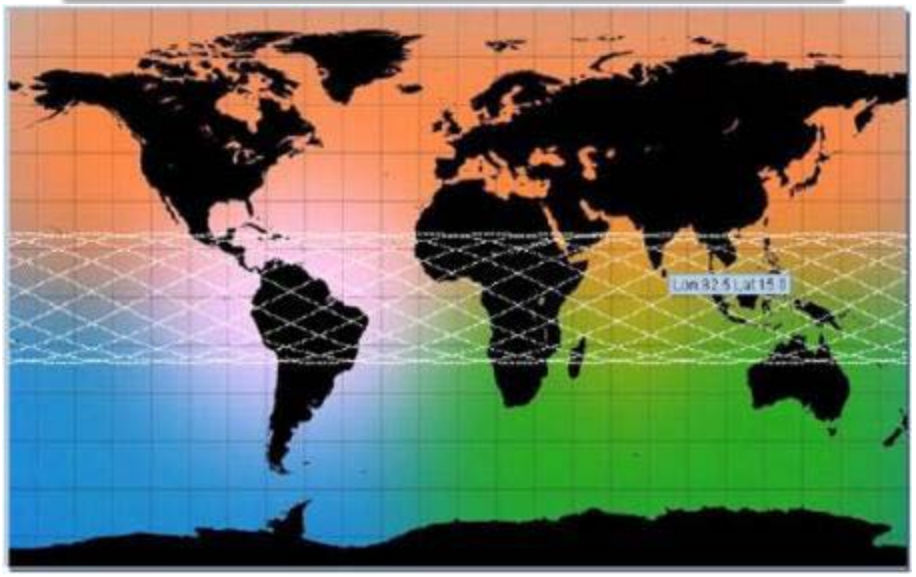
MADRAS

- Precipitation and Cloud properties
- 89 &157 GHz: Ice particles in cloud top
- 18 &37 GHz: Cloud Liquid Water and precipitation; Sea Surface Wind speed
- 24 GHz : Integrated water vapour

Applications:

Observations of tropics for

- Water vapour
- Clouds
- Cloud condensed water
- Precipitation
- Evaporation

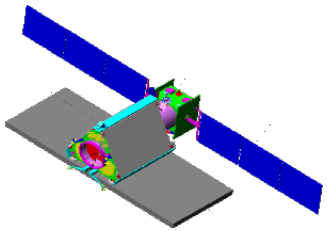


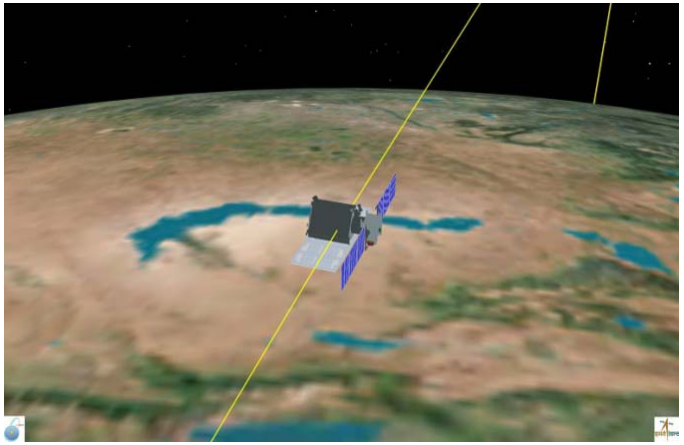
Radar Imaging Satellite (RISAT-1) (2012)

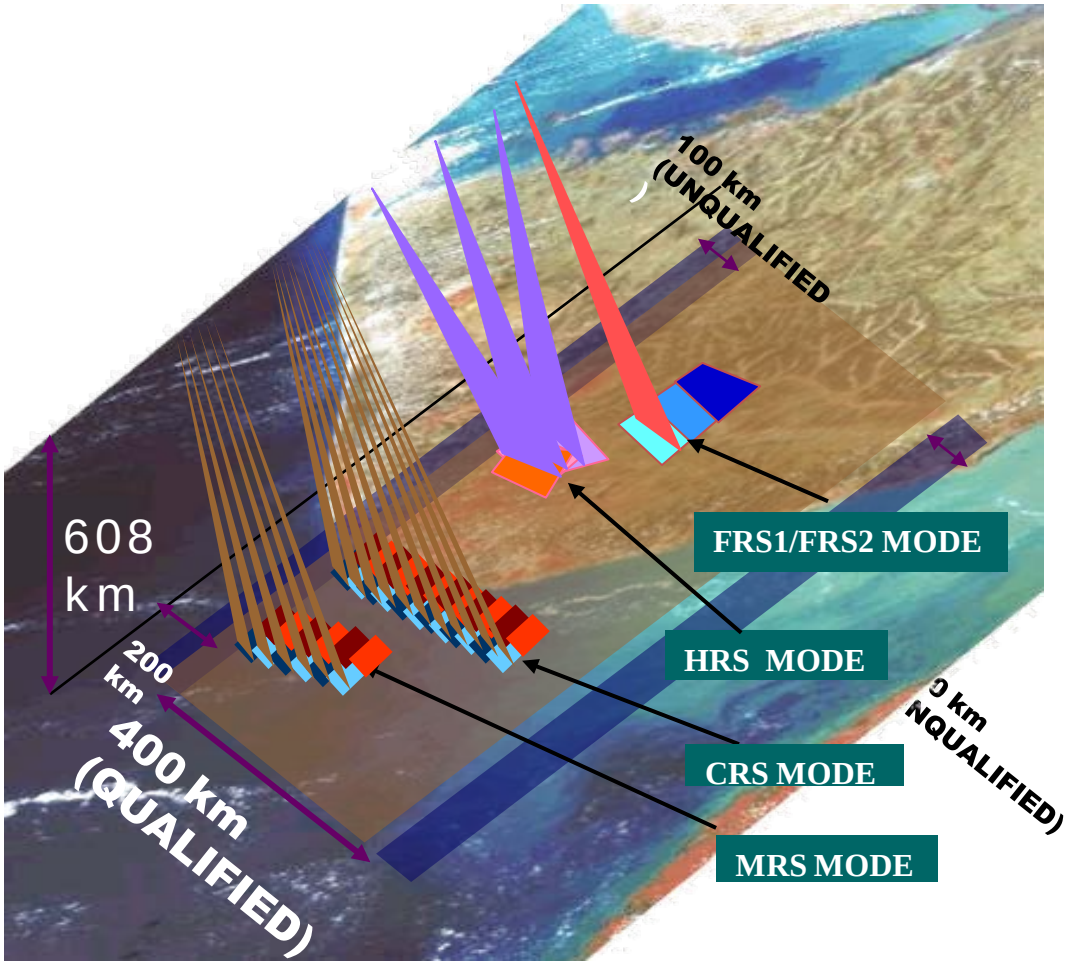
Space borne SAR in C-band at 5.35 GHz

- Stripmap FRS-1 / FRS-2 (Range Doppler/ Chirp Scaling)
- ScanSAR MRS & CRS (Range Doppler/Specan)
- Spotlight (modified sub-aperture) modes.

Single/ Dual / Quad Polarisation imaging with 3 - 50 m Resolution & 10 - 240 km Swath



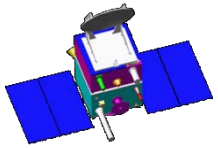




SARAL: Satellite with Argos and Altimeter (2013)

Altika/SARAL mission belongs to the global altimetry system for the precise and accurate observations of ocean topography, circulation and sea surface monitoring

French (CNES)- Indian (ISRO) Collaboration

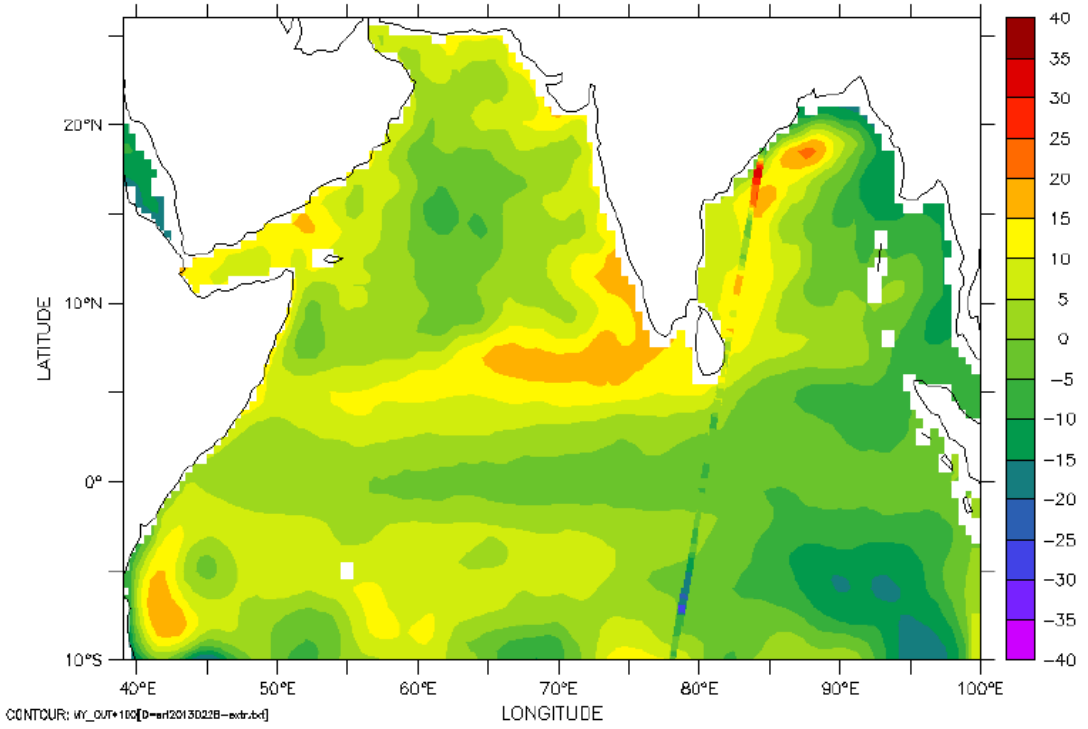


Mission:

- Sun-synchronous, polar orbiting satellite
- Inclination: 98.38 Deg.
- Altitude: ~800 km
- Repeat cycle: 35 days

Altika Payload:

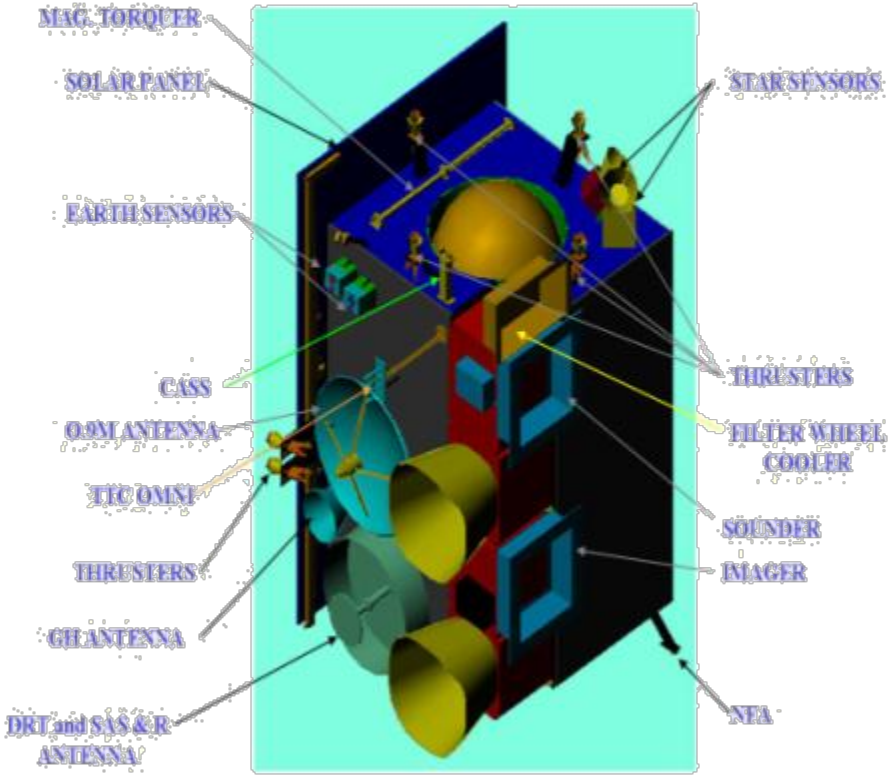
- Ka-band (35.75 GHz, BW 500 MHz) radar altimeter
- Dual-frequency microwave radiometer (23.8 & 37 GHz)
- DORIS
- Laser Retro-reflector Array



SARAL/AltiKA SSHA observation overpass over Indian Ocean on Feb 28, 2013 and SLA from POM model at 0.5 degree resolution.

INSAT-3D (2013)

Follow Mission to Kalpana



Payloads:

IMAGER

- Spectral Bands (6): VIS, SWIR, MWIR, WV, TIR- 1 &2
- Spatial Resolution: 1 km for VIS & SWIR
  4 km for MIR & TIR
  8 km for WV

SOUNDER – Water Vapour & Temperature profiles

- Spectral Bands (19): SWIR (6), MWIR (5), LWIR (7), Vis (1)
- Resolution (km): 10 X 10 for all bands
- No of simultaneous sounding : 4 per band

Data relay Transponder; Search & Rescue Payloads

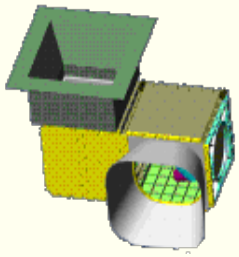
Potential Applications

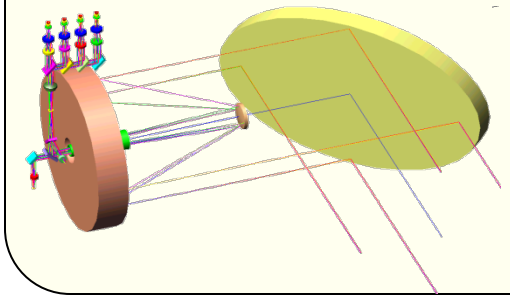
Quantitative precipitation estimation, vertical temperature and moisture profile of the atmosphere, surface and cloud top temperatures, ozone distribution, Sea Surface Temperature (SST), fire, smoke, fog detection, etc.

INSAT - 3DR

LAUNCH: 2016

Advanced weather satellite of India configured with improved Imaging System and Atmospheric Sounder





6 Channel IMAGER

- **Spectral Bands (µm)**

Visible	: 0.55	- 0.75
Short Wave Infra Red	: 1.55	- 1.70
Mid Wave Infra Red	: 3.70	- 3.95
Water Vapour	: 6.50	- 7.10
Thermal Infra Red – 1	: 10.30	- 11.30
Thermal Infra Red – 2	: 11.30	- 12.50

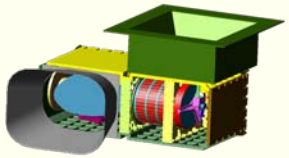
- **Resolution** : 1 km for Vis & SWIR
  4 km for MIR & TIR
  8 km for WV

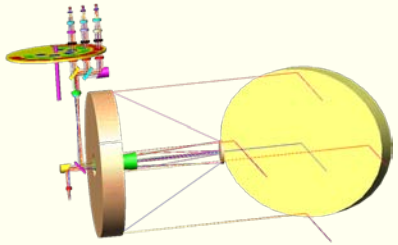
19 Channel SOUNDER

- **Spectral Bands (µm)**

Short Wave Infra Red	:	Six bands
Mid Wave Infra Red	:	Five Bands
Long Wave Infra Red	:	Seven Bands
Visible	:	One Band

- **Resolution (km)** : 10 X 10 for all bands
- **No of simultaneous** : 4 sounding per band





Geo Imaging Satellite (GISAT)

LAUNCH: 2016-17

LAUNCH: 2016-17

- **Multiple acquisition capability from a Geosynchronous Orbit**
- **Geostationary orbit of 36,000 km**
- **Every 30 minutes observation over India**

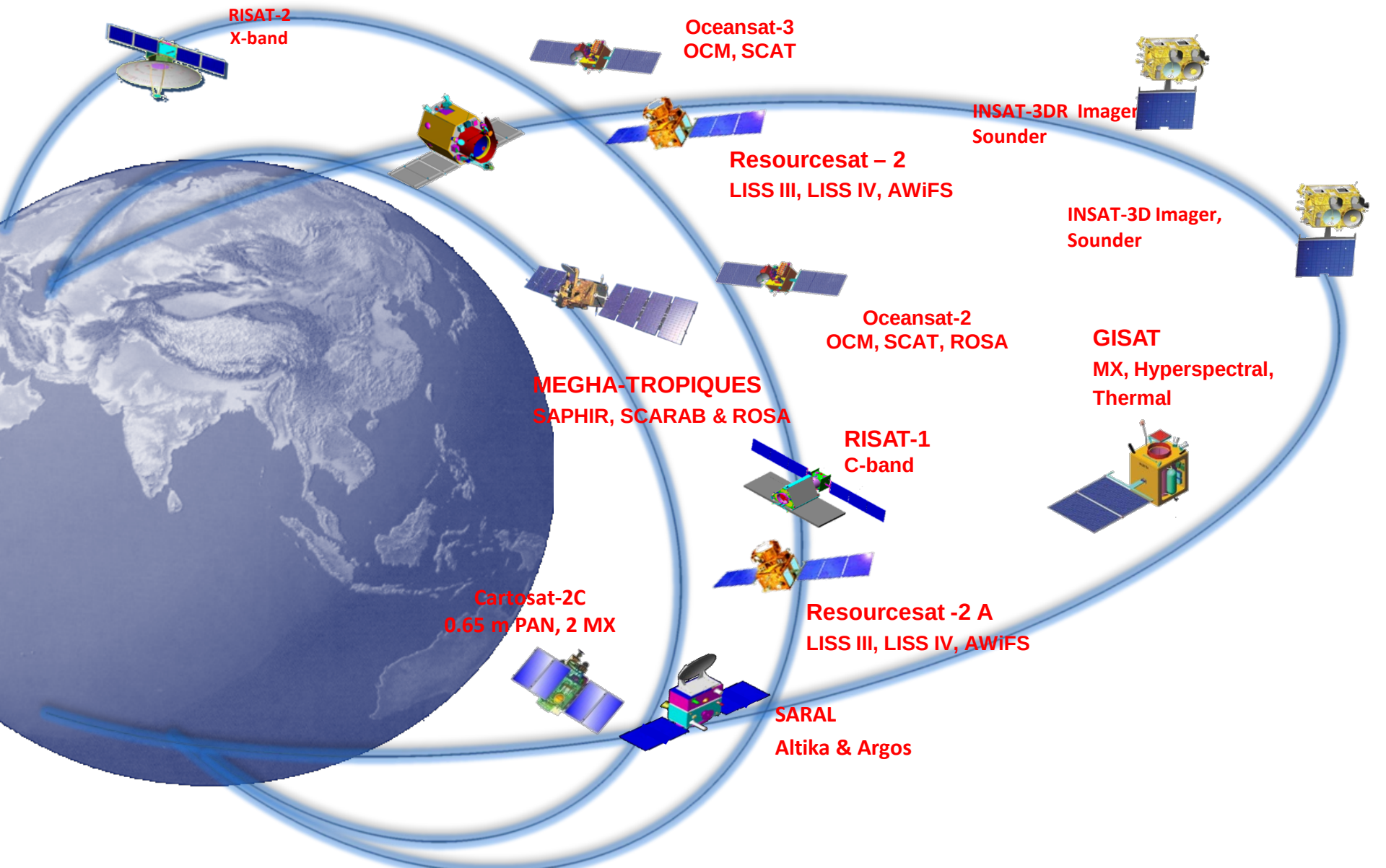
High resolution multi-spectral VNIR (HRMX-VNIR): 50m Resolution

Hyper spectral VNIR: 320m Resolution

Hyper spectral SWIR (HySI-SWIR): 192m Resolution

High resolution Multi-spectral (HRMX-TIR): 1.5km Resolution

Scenario in next 5 Years

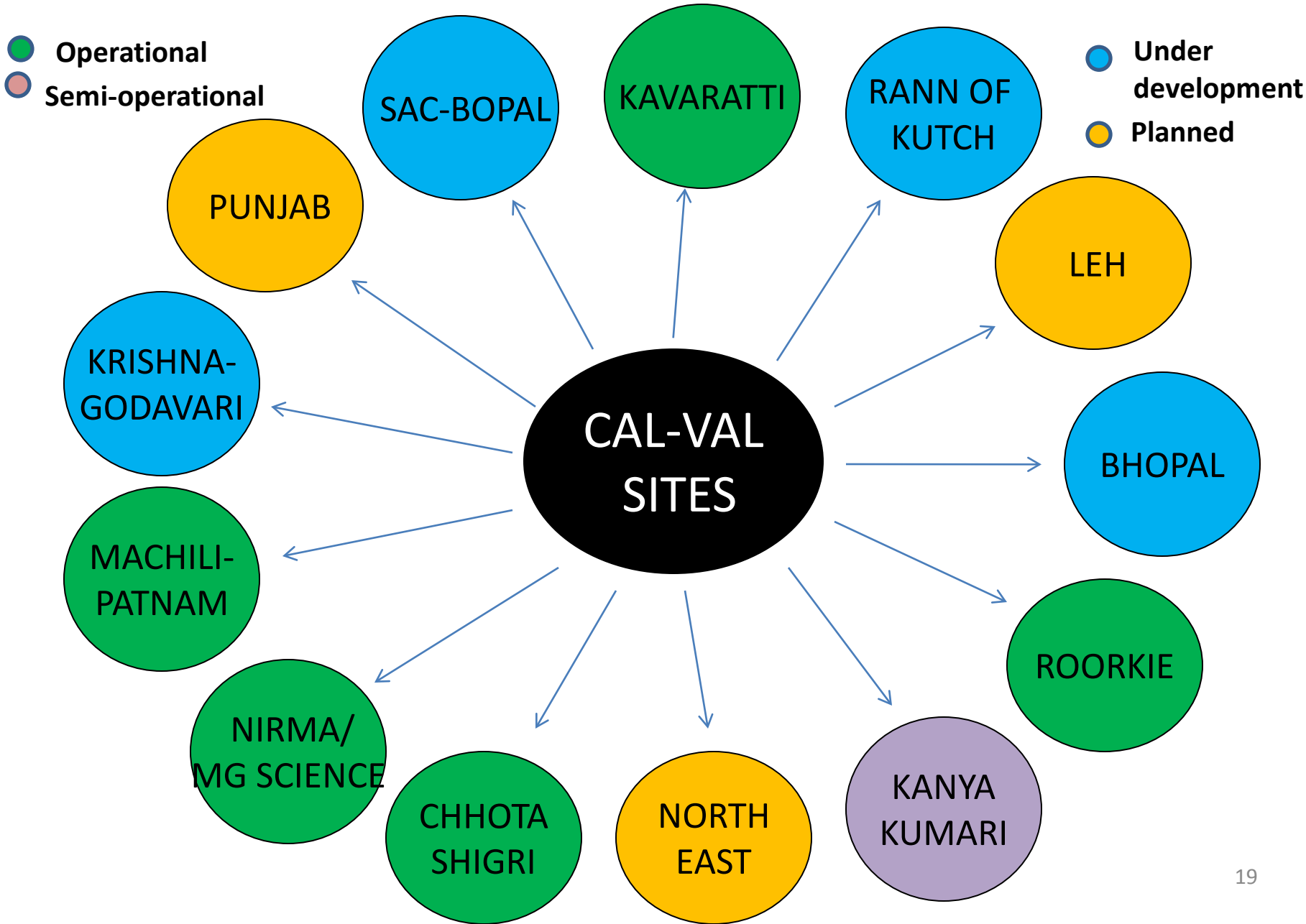


ISRO Cal Val Activities - Overview

- Establishing an Indian Cal-Val Program - by setting up instrumented CAL sites for theme-oriented ISRO missions.

- Collaborating with WGCV teams for Inter-Sensor Calibration with contemporary sensors over CEOS specified global calibration sites.

INDIAN NETWORK OF CALIBRATION & VALIDATION SITES FOR LAND, OCEAN AND ATMOSPHERE (FP: A.K. Shukla)



Functional Activities of Indian Cal-Val Sites

Sr. No.	Name of site	Type	Project	Sensor	Parameters/products
1	Kavaratti	Ocean/ Atmos-phere	Oceansat-2, Saral/AltiKa, Meghatropiques	OCM-2, Scatterometer, Radar Altimeter,Madra Sapphire, ScaRaB	VC, nLw, Rsr, Chl, AOD, SSA, WV, TSM, Kd, WS, WD, Vertical profile of atmosphere, SSH, AP, AT,SST, Oz.
2	Rann of Kutch	Land/ Atmosp here	Resourcesat-2, Meghatropiques, INSAT-3D,RISAT-	AWIFS, LISS-3, Madras, Sapphire, ScaRaB, Imager, Sounder, SAR	VC, SR, AOD, SSA, WV, WS, WD, AP, AT,LST, Ozone, Vertical profile of atmosphere, SM, SAR cal.
3	SAC-Bopal	Land/ Atmosp here	Resourcesat-2, Cartosat-2 Meghatropiques, RISAT-1,INSAT-3	LISS-4, PAN, Sapphire, ScaRaB, Madras, SAR, Imager, Sounder	VC, GC, SR, AOD, SSA, WV, WS, WD, AP, AT, SST, Ozone, SM, SAR cal.
4	Bhopal	Land/ Atmosp here	Resourcesat-2, Meghatropiques, INSAT-3D	AWIFS,LISS-3, Sapphire, ScaRaB, Madras, Imager, Sounder	LPV, SR, LAI, NDVI, AOD, SSA, WV, WS, WD, Vertical profile of atmosphere, AP, AT,WS,WD, Ozone
5	Krishna Godavar i (KG)	Coastal ocean/ Atmosp here	Oceansat-2, Saral/AltiKa, Meghatropiques, INSAT-3D	OCM-2, Scatterometer, Radar Altimeter, Sapphire, ScaRaB, Madras, Imager,Sounde	PV, nLw, Rsr, Chl, AOD, SSA, WV, TSM, Nitrate, Phosphate, BS, PAR, WS, WD, Vertical profile of atmosphere, SSH, AP, AT, SST
6	Machilip atnam	Coastal ocean	Saral/AltiKa	Radar Altimeter	SSH

Functional Activities of Indian Cal-Val Sites (2)

Sr. No.	Name of site	Type	Project	Sensor	Parameters/products
7	Kanya kumari	Caostal ocean	Saral/AltiKa	Radar Altimeter	SSH
8	Nirma/ MG Sci.	Land	RISAT-1	SAR	SAR cal., Soil Moisture
9	Roorkie	Land	RISAT-1	SAR	SAR cal., Soil Moisture
10	Chhota Shigri	Land/ Atmosphere	Resourcesat-2, Meghatropiques, INSAT-3D	AWIFS,LISS-3, Sapphire, ScaRaB, Madras, Imager, Sounder	Snow cover, SR, AOD, SSA, WV, WS, WD, AP, AT, Ozone
11	Punjab (planned)	Land/ Atmosphere	Resourcesat-2, Meghatropiques, INSAT-3D	AWIFS,LISS-3, Sapphire, ScaRaB, Madras, Imager, Sounder	LPV, SR, LAI, NDVI, AOD, SSA, WV, WS, WD, Vertical profile of atmosphere, AP, AT, Ozone
12	North East (planned)	Land/ Atmosphere	Resourcesat-2, Meghatropiques, INSAT-3D	AWIFS,LISS-3, Sapphire, ScaRaB, Madras, Imager, Sounder	LPV, SR, LAI, NDVI, AOD, SSA, WV, WS, WD, Vertical profile of atmosphere, AP, AT, Ozone
13	Leh (planned)	Land/ Atmosphere	Resourcesat-2, Meghatropiques, INSAT-3D	AWIFS,LISS-3, Sapphire, ScaRaB, Madras, Imager, Sounder	Instrument calibration, SR, AOD, SSA, WV, WS, WD, Vertical profile of atmosphere, AP, AT, Ozone

Activities carried out in 2013

- Development activities of Cal-Val sites in Rann of Kutch (medium and coarse resolution), SAC-Bopal, Ahmedabad (high resolution) and in Bhopal (Land Product Validation). The site consists of land and atmospheric fully automated in-situ parameter measuring instruments (e.g. surface reflectance, AOD, SSA, Rain fall/rate, weather para., etc.)
- Development initiated for a Coastal site in Krishna-Godavari basin.
- Vicarious calibration of OCM using Kavaratti Cal-Val site, Resourcesat-2 sensors using Rann of Kutch site and inter-comparison with Landsat-7, absolute calibration of Saral Radar altimeter of using Kavaratti site, RISAT-1 SAR calibration using Ahmedabad sites.
- Validation of OCM2,AWIFS,Saral,Meghatropiques,INSAT-3D products.



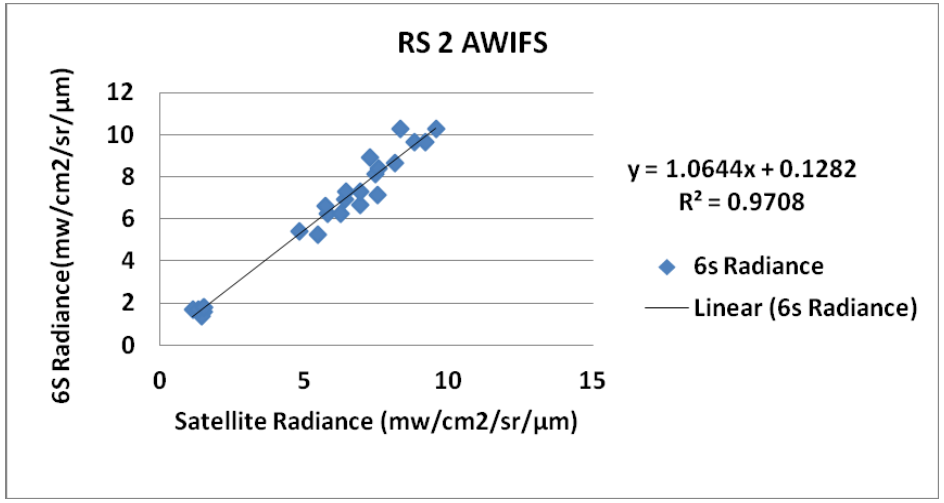


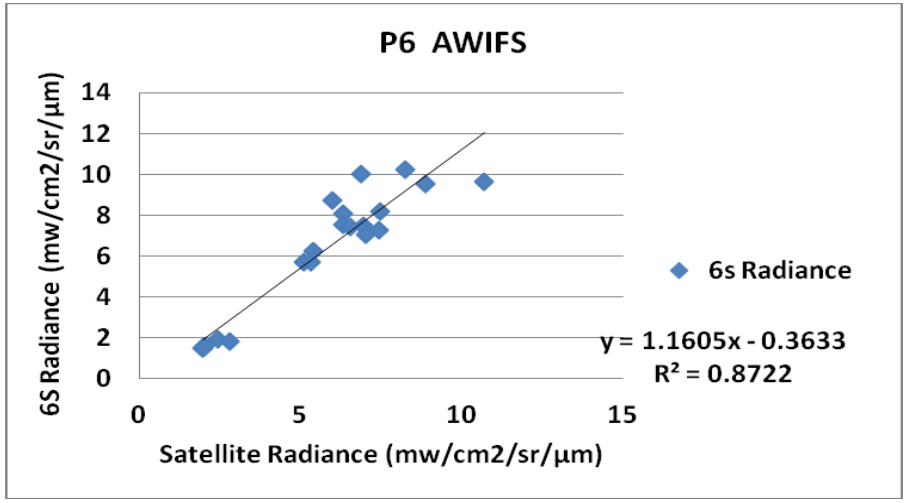

Future plan of action in 2014

- Operationalization of Rann-of-Kutch, SAC-Bopal and Bhopal sites
- Development and operationalization of Coastal site for ocean color
- Periodic vicarious calibration of ISRO sensors, implementation of gain coefficients and inter-comparison(other sensors) using sites
- Operational validation of Bio-geo-physical products using sites
- Feasibility studies and site selection for planned sites development
- Operationalization INCVSLOA and database for all sites
- International collaboration and data exchange for all sensors




RESOURCESAT-2/IRS-P6

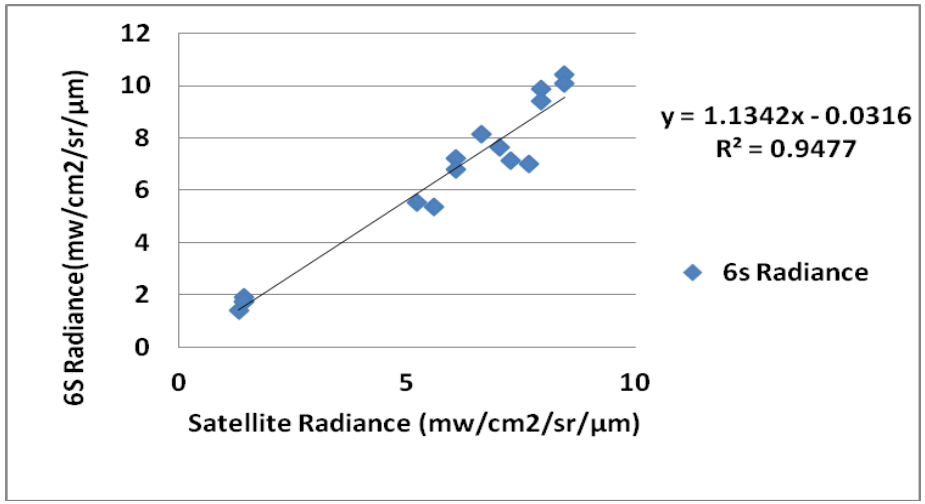




Sensor / Band	Radiance (mw/cm2/sr/ micron)	S.D.	Ratio (RS2/6S)	S.E.
RS2 green	7.85	0.16	0.91	0.17
6S green	8.57	0.9		
RS2 red	7.72	0.19	0.94	0.11
6S red	8.19	0.58		
RS2 NIR	5.87	0.14	0.92	0.09
6S NIR	6.34	0.46		
RS2 SWIR	1.40	0.03	0.84	0.02
6S SWIR	1.67	0.14		

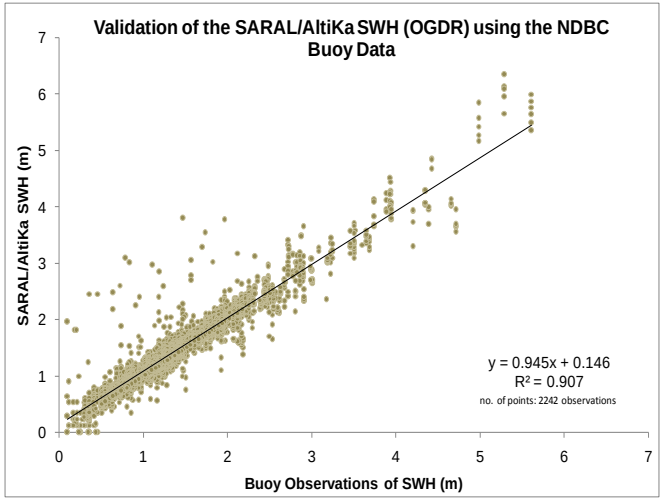
Sensor / IRS-P6	Radiance (mw/cm2/sr/ micron)	S.D.	Ratio (P6/6S)	S.E.
P6 green	6.75	0.14	0.76	0.16
6S green	8.87	1.02		
P6 red	8.21	0.21	0.99	0.19
6S red	8.33	0.94		
P6 NIR	5.96	0.13	0.92	0.13
6S NIR	6.47	0.67		
P6 SWIR	2.24	0.04	1.34	0.04
6S SWIR	1.67	0.15		

Landsat-7

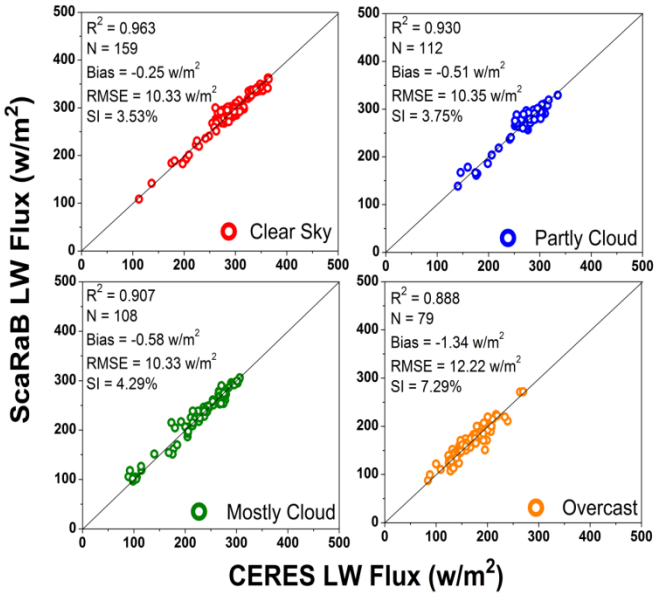


Sensor / Band	Radiance (mw/cm2/sr/ micron)	S.D.	Ratio (RS2/6S)	S.E.
L7 green	7.93	0.71	0.90	0.19
6S green	8.79	0.74		
L7 red	7.5	0.56	0.87	0.15
6S red	8.64	0.55		
L7 NIR	5.7	0.36	0.91	0.12
6S NIR	6.23	0.51		
L7 SWIR	1.36	0.17	0.81	0.05
6S SWIR	1.67	0.26		

Saral/AltiKa

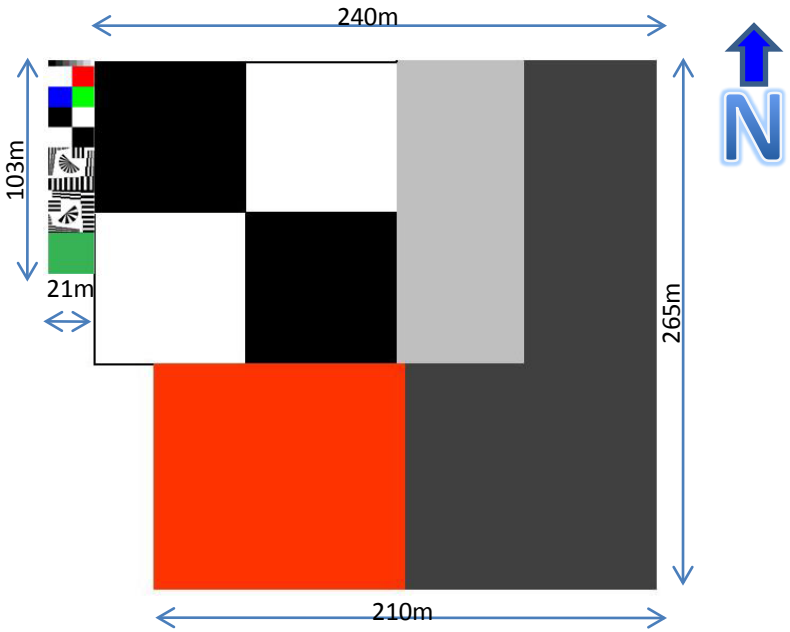


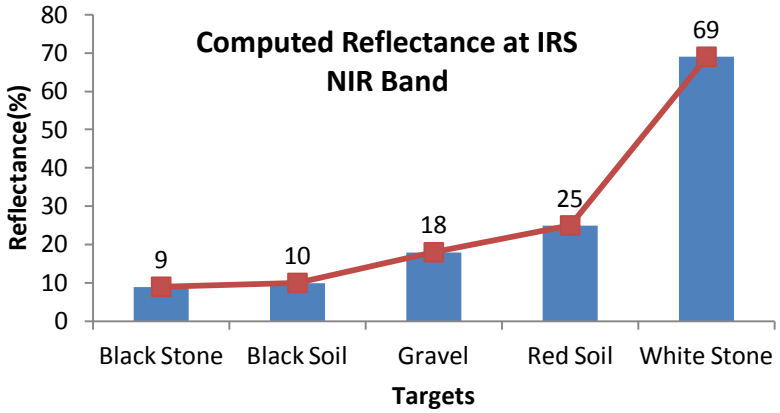
Meghatropiques



Infrared Visible Optical Sensors (IVOS) CAL-VAL Site @NRSC

(FP: A. Senthil Kumar)





Salient Features:

- First Integrated site, to characterize Aerial and Satellite sensors at one location. Site is constructed with sub-soil drainage system to protect soil erosion and water logging.

Characterization of Aerial sensors (GSD <= 1.3m):

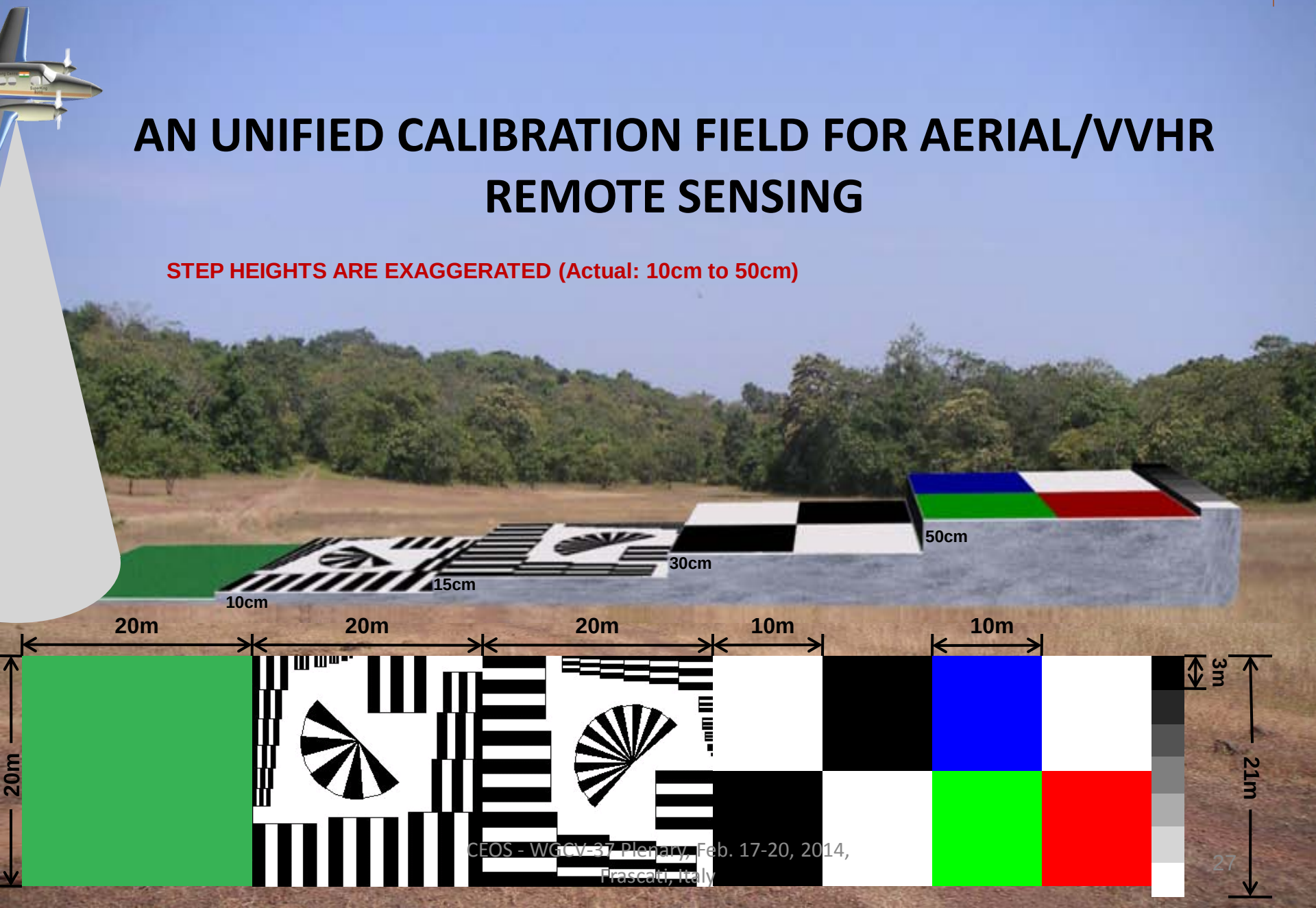
- Spectral -Red, Green, Blue & White Colors.
- Radiometry -Seven grey levels in White-Black.
- Spatial : Bar, Siemens star and High contrast edge targets.
- Height: Six discrete steps in 10-50 cm range.

Characterisation of Satellite sensors (GSD <= 24m):

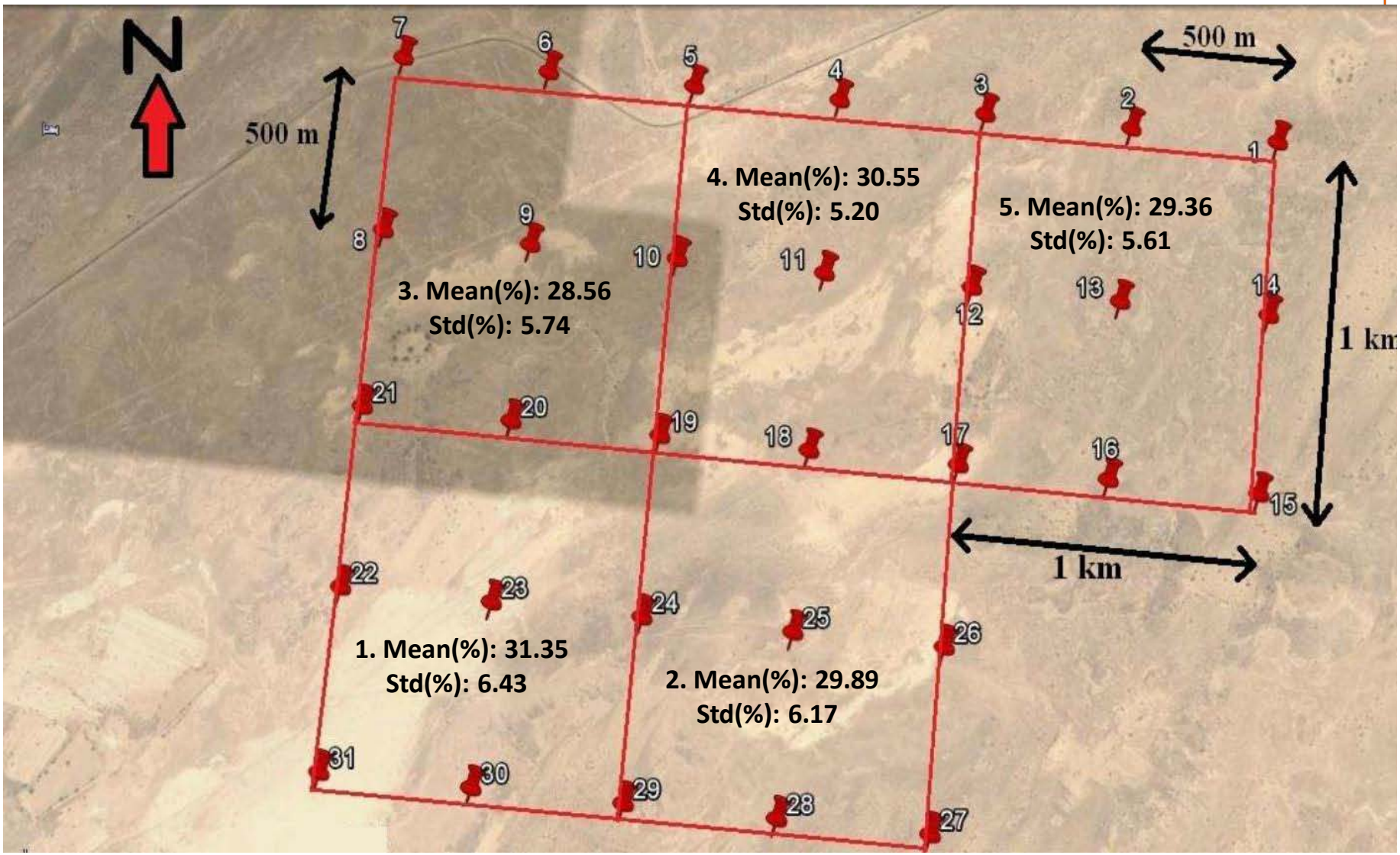
- Radiometry; Five natural targets with R=9-69 %.
- Sensor spatial quality MTF -High contrast edges.
- In-situ measurements: Met, Atmospheric & surface reflectance measurements at the site.

AN UNIFIED CALIBRATION FIELD FOR AERIAL/VVHR REMOTE SENSING

STEP HEIGHTS ARE EXAGGERATED (Actual: 10cm to 50cm)



Jaisalmer site- Reflectance in INSAT-3D Vis-channel



Statistics over 5 Tiles:
Mean of Mean: 29.94 %
Mean of Std : 5.83 %

INSAT-3D Vis-Channel: 0.55 to 0.75 microns

Joint Calibration Exercise:
RS2 AWIFS & MODIS Cross Calibration over Libya-4 CEOS Site

Collaboration with MODIS (NASA) – FP: Jack Xiong

- Cross calibration was based on 14 AWIFS acquired during June 2011 – Dec. 2012 and corresponding day data of MODIS
- BRDF, Spectral Mismatch, Water Vapor effects are compensated to obtain Radiometric Bias* between two sensors

$$* Bias = \frac{\rho_{MODIS}^{TOA}}{\rho_{AWIFS}^{TOA}}$$

Bands	TERRA -	Bias	CE-95 Limits	Std. Dev. (%)
AWIFS B2	MODIS B4	1.014	0.967 – 1.06	8.552
AWIFS B3	MODIS B1	1.027	0.994 – 1.06	6.095
AWIFS B4	MODIS B2	1.045	1.020 – 1.069	4.513
AWIFS B5	MODIS B6	1.096	1.061 – 1.130	6.302

Bands	AQUA -	Bias	CE-95 Limits	Std. Dev. (%)
AWIFS B2	MODIS B4	1.012	0.962 – 1.061	9.076
AWIFS B3	MODIS B1	1.024	0.992 – 1.056	5.871
AWIFS B4	MODIS B2	1.045	1.016 – 1.074	5.347
AWIFS B5	MODIS B6	-	-	-

Results:

1) Biases for AWIFS B2, B3 within 2% while ~4.5% for B4
2) Bias is about 9.6% for AWIFS B5
3) Std. Dev. is higher; further acquisitions /long term analysis in progress.

Joint Calibration Exercise:
LISS4 Calibration Exercise over CEOS Geometric Sites (Sioux Falls, Pueblo)

Collaboration with USGS – FP: Greg Stensaas

- **Statistics generated were from 560 and 670 control points.**
- **Control points from a high resolution, high accuracy (<60cm) aerial imagery.**

Band Misregistration Error (Specs: ± 0.3 p RMSE)

Parameter	Red (B3) – Green (B2)	
	Line (AL)	Pixel (AX)
Min	-0.24	-0.32
Mean	0.00	0.00
Max	0.25	0.32
RMSE	0.12	0.16

Parameter	Near IR (B4) – Red (B3)	
	Line (AL)	Pixel (AX)
Min	-0.34	-0.28
Mean	-0.02	-0.03
Max	0.30	0.22
RMSE	0.17	0.13

Location Inaccuracy Specs: < 200m RMSE

Parameter	Location Error pixels (in m)	
	Line (AL)	Pixel (AX)
Min	0.75	4.3
Mean	28	19.7
Max	55.4	35.1
Std.Dev.	14	7.9
RMSE	**31.3**	**21.2**

In Progress:

- **Radiometric Calibration with L7/L8 over CEOS sites**
- **Geometric calibration to be repeated for consistency**

RISAT-1 Calibration Exercise at Gunning (Canberra, Australia)

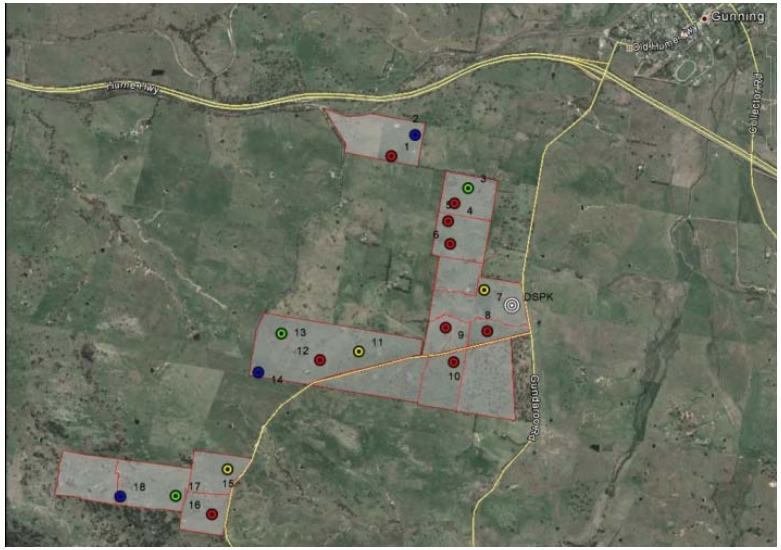
Collaboration with Geoscience, Australia – FP: Medhavy

Joint Calibration Exercise - with Passive Corner Reflectors
Image Acquisition planned between Dec13 and Mar14

18 Triangular Trihedrals installed at Location ~ (149.20 Lat/-34.8 Long)

CR Type	CR No.	CR Size (m)
Mesh	1,6,10	1.5
Powder	4,9,12	1.5
Metal	(7,11,15) (5,8,16) (3,13,17) (2,14,18)	1.0 1.5 2.0 2.5

CR Array Lay-out Map



Installation completed by 20DEC13

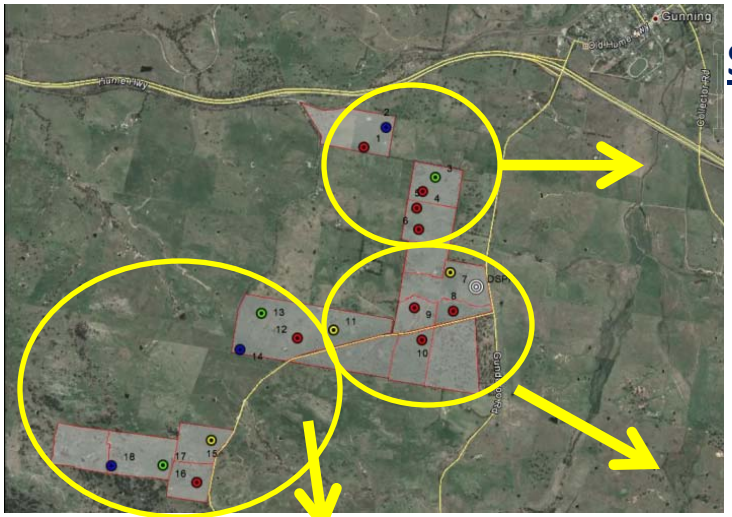
RISAT-1 Imaging and Processing in progress

Background Clutter Analysis

RISAT-1 Imaging on 17Nov13 **Inc Angle : 21.01 deg**

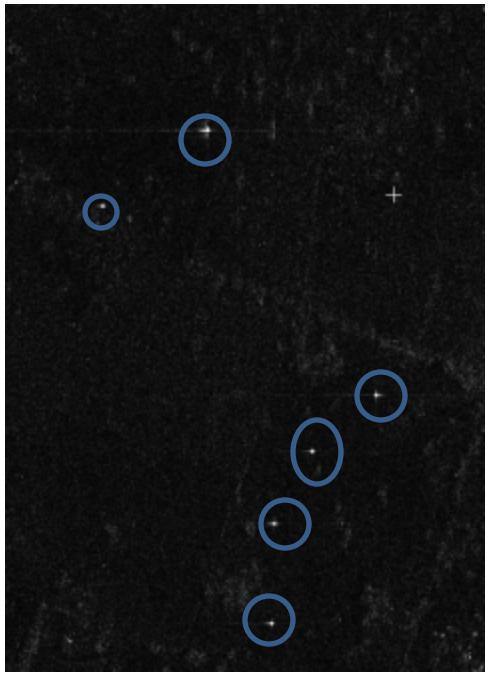
CR	σ_o	CR	σ_o
1,2	11.36	12	10.78
3,4	11.32	13	10.41
5,6	10.15	14	11.24
7	10.19	15	10.99
8	10.0	16	10.59
9	9.93	17	10.04
10	9.22	18	10.55
11	9.26		

RISAT-1 Imaging of CRs at Gunning

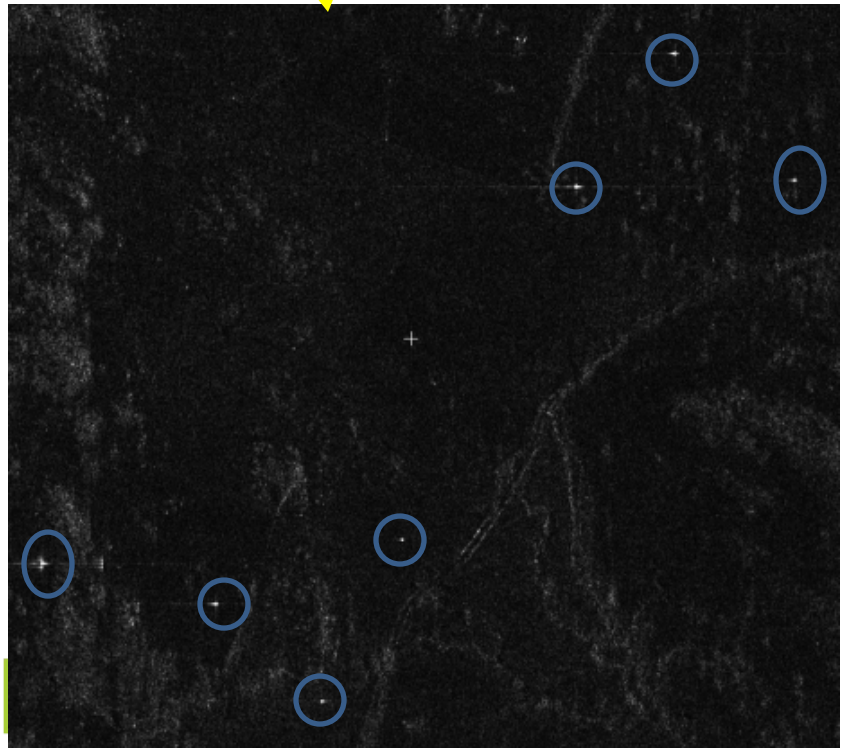


Site map

CRs 1 to 6 >

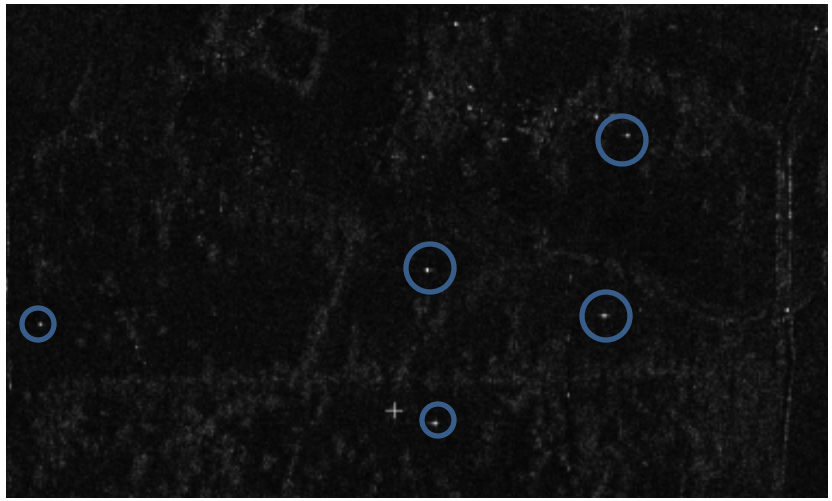


Imaging



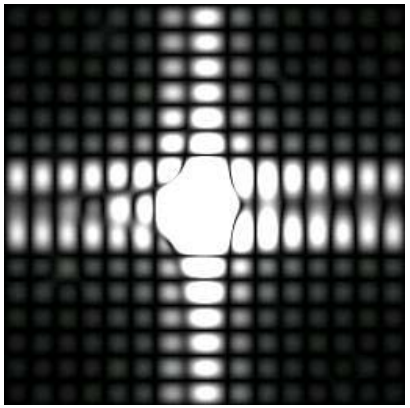
< CRs 12 to 18

CRs 7 to 11 V



Preliminary Results

Radar Parameters		Scene Information	
Img Mode	FRS1	Prod Type	L1 - SLC
Node	Descending	Date of Pass	3-Feb-14
Orientation	Left	Orbit	9785
Polarization	HV, HH	Scene	5
Radar WL	0.056m	Beam No.	85
PRF	2930	Scene Cntr Ang	31.48



Response of CR#10

RISAT-1 Imaging of CRs 7-12

CR#	TYPE	Size	Loc. Incid. Ang. (deg)	PSLR (dB)		Res. (m)	
				Azimuth	Range	Azimuth	Range
7	Metal	1.0m	31.64	**-24.4**	**-19.38**	3.92	2.25
8	Metal	1.5m	31.63	**-20.79**	**-15.85**	4.97	2.47
9	Metal	1.5m	31.67	**-22.7**	**-17.15**	3.47	2.36
10	Mesh	1.5m	31.65	**-18.29**	**-17.58**	5.12	2.7
11	Powder	1.0m	31.73	**-26.35**	**-21.34**	3.47	2.36

Specs: PSLR = -17db

Summary

- Indian Cal-Val program – aiming to set up instrumented cal-val site for radiometric calibration and land/ocean/atmospheric information products validation.

- Collaboration with CEOS WGCV in joint campaigns for inter-sensor calibration and validation pertaining to ECVs and SBA information products.

Thank you for your attention