<ISRO>
Report on Cal/Val Activities

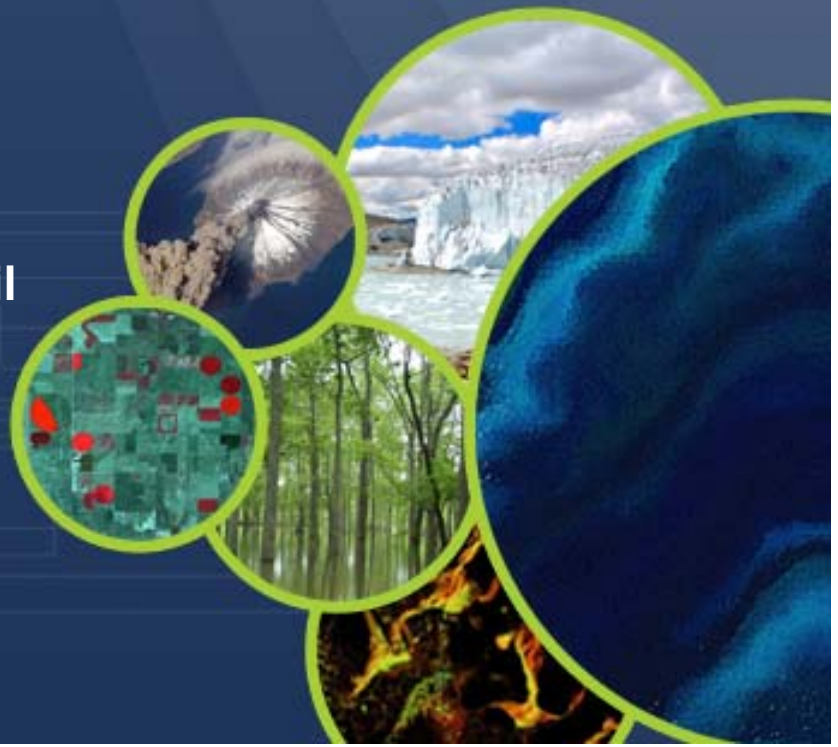
Arundhati Misra

ISRO

Agenda Item #

WGCV # 43, São José dos Campos, SP, Brazil

April 10-13, 2018



6. Agency updates

- **Agency reporting**
- **ISRO – Dr. Arundhati Misra**
- **Update on the Calibration and Validation activities from ISRO**
  - **TOPICS**
    - **SAR**
    - **Scatterometer**
    - **AVIRIS-NG**
    - **Insat 3D**

NISAR Calibration Plan

Commissioning phase

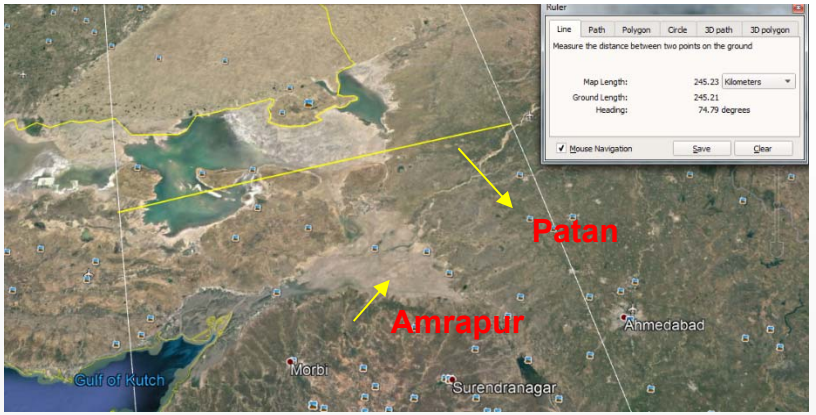
External Calibration plan

S. No.	Parameter	Radar Mode	Ground target
1.	Thermal noise calibration	Prime modes	
2.	Digital beam forming calibration	All modes	Distributed targets
3.	Antenna pattern verification	Prime modes	Distributed + point targets
4.	Differential Time delay	Quad pol	Point targets
5.	Radiometric calibration	All modes	Distributed + point
6.	Cross-talk calibration	Quad-pol	Distributed + point
7.	Polarimetric calibration	Dual pol, Quad pol and CP	Distributed+ point
8.	Geometric calibration	Prime modes	Point targets
9.	Noise equivalent sigma0	All modes	Calm water bodies
10.	PSLR, ISLR, range and azimuth resolution	All modes	Point targets
11.	Radiometric accuracy	All modes	Distributed targets
12.	Split Spectrum calibration	Prime modes	Point Targets

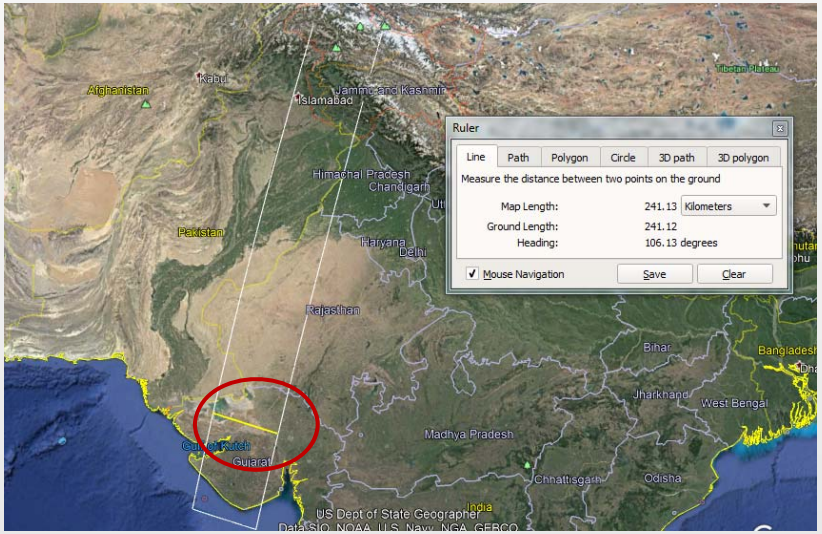
Science Calibration phase

- ***Calibration parameters stability assessment***
- ***Cross calibration with Other sensors – Experimental (Airborne Data of L&S Band SAR-baseline over Indian Sites)***
- ***Planning Co-Temporal and Co-Spatial acquisitions at similar incidence angles with other L - S band SAR missions***
- ***Validation of L3/L4 products.***

Simulated NISAR Coverage for Ascending Pass



- Based on the STK simulation for NISAR coverage over India, calibration sites have been identified in the near range and mid-range swath.
- Discussions carried out with the collaborative agency (Patan University, Gujarat). The formalities related to Memorandum of understanding (MoU) will be completed soon.
- Identification of potential calibration sites in the far-range is in progress.



Simulated NISAR coverage for Descending Pass

NISAR Calibration Validation Plan-Calibration Sites

Point Target Sites

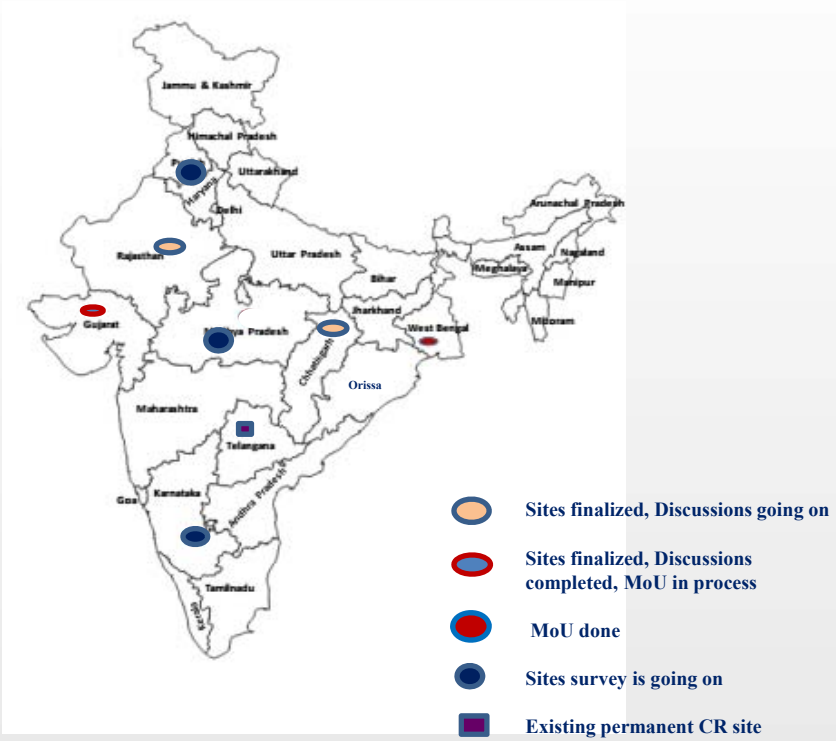
Indian Sites

- It is planned to permanently deploy different types and sizes of corner reflectors at additional sites (educational institutes, regional remote sensing centres) in each state of India to cover all the beams of S-band.
- In the first phase, permanent deployment of CRs in six Indian states (Gujarat, West Bengal, Rajasthan, Chhatisgarh, Karnataka, Punjab and Madhya Pradesh) has been initiated.
- For L-band beams, campaign modes will be carried out in various Indian sites in joint-mode with S-band for the external calibration.

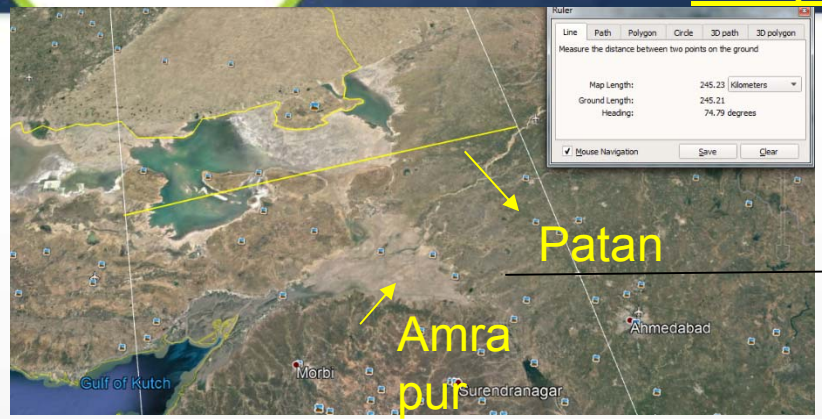
International Sites

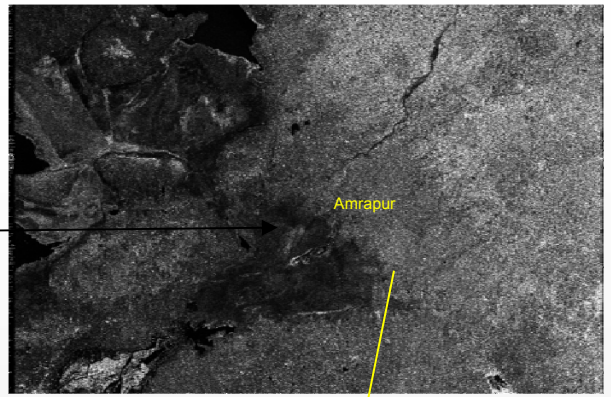
- A survey near Bharti station in Antarctica was conducted by SAC officials for selecting the suitable point target site at Antarctica.

CAL VAL NETWORK



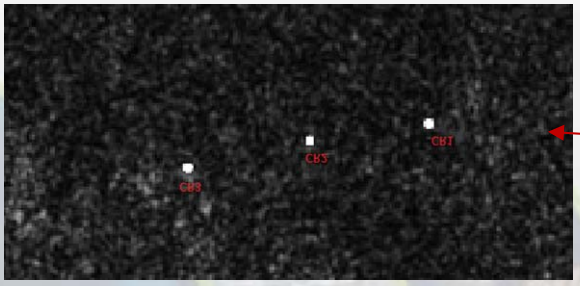
Amrapur site response study

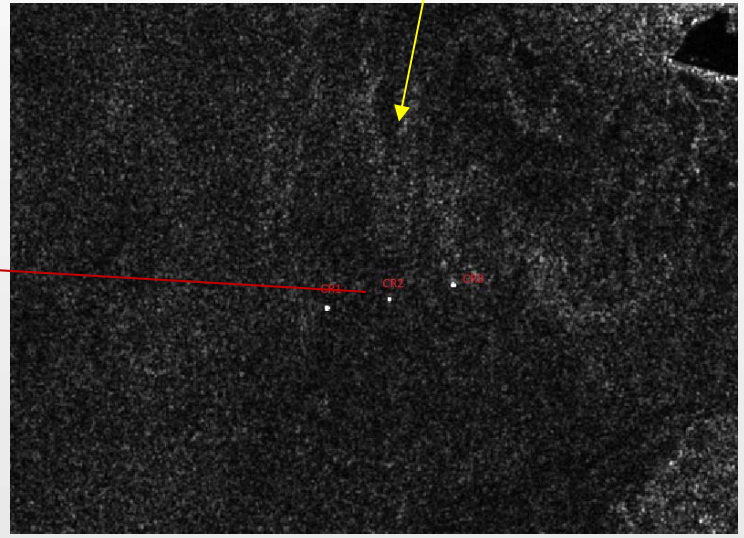




Sentinel-1 image of Amrapur site (6th February 2018)

Simulated NISAR Coverage for Ascending Pass





Ground Photo Amrapur

		Date:6-Feb-18			
		Site : Amrapur			
CR. No.	CR Type	Polarisation	Calc. RCS (in dB)	Theor. RCS (in dB)	Diff.(in dB)
1	TT(0.9m)	VV	29.10	29.51	0.41
2	TT(0.9m)	VV	26.75	29.51	2.76
3	TT(0.9m)	VV	28.74	29.51	0.77

Field campaign synchronous to L&S Airborne SAR flight was carried out during 22-25 June 2017 at Desalpar Cal-Val site in Rann of Kutch for SAR calibration. First time NavIC Rx were used for SAR Calibration Campaign in SAC.

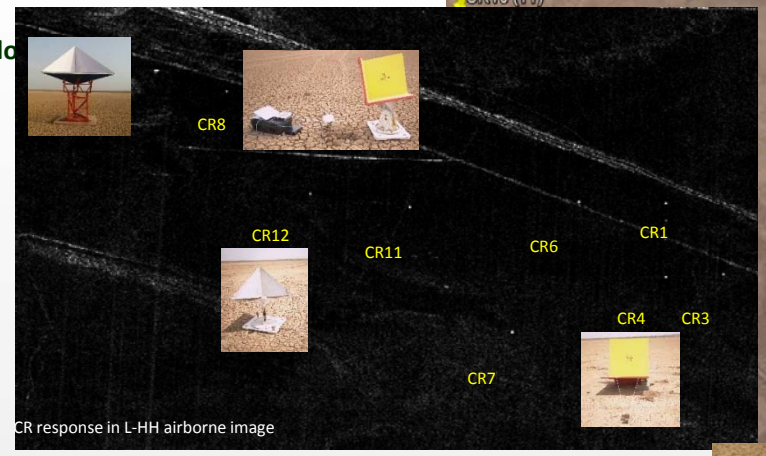
Twelve Corner reflectors (CRs) of different shapes and sizes were deployed according to sensor parameters.

The details of the deployed CRs are as follo

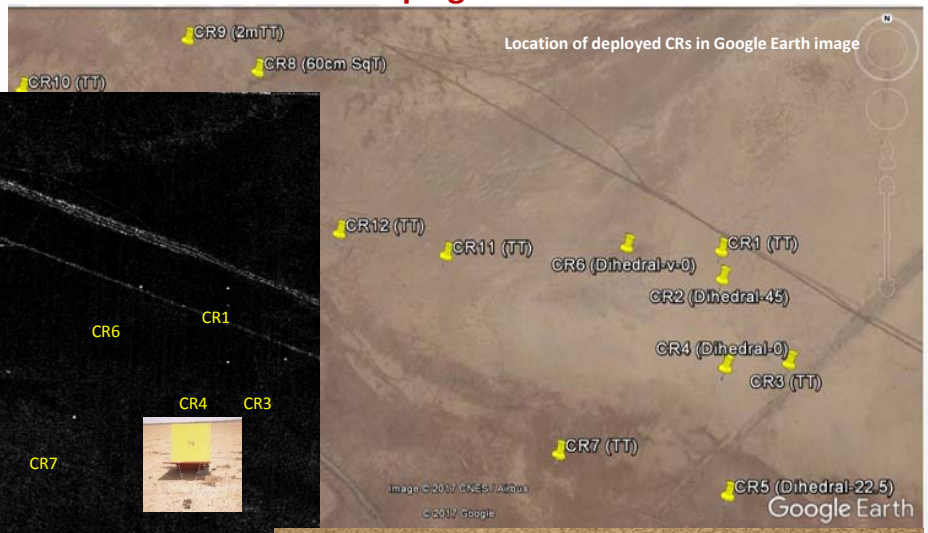
1. **Triangular trihedral (90 cm & 2m)**
2. **Square Trihedral (60 cm)**
3. **Dihedral (1.2 m)**

CRs response is visible in the image as a bright white spot.

White lines seen in L-HH images are the recently dug-up canals which are being used by farmers to irrigate their fields.



CR response in L-HH airborne image

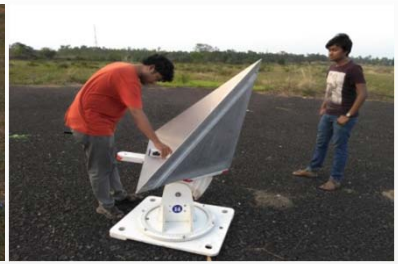


Differential NavIC Precise Positioning using NavIC Receivers

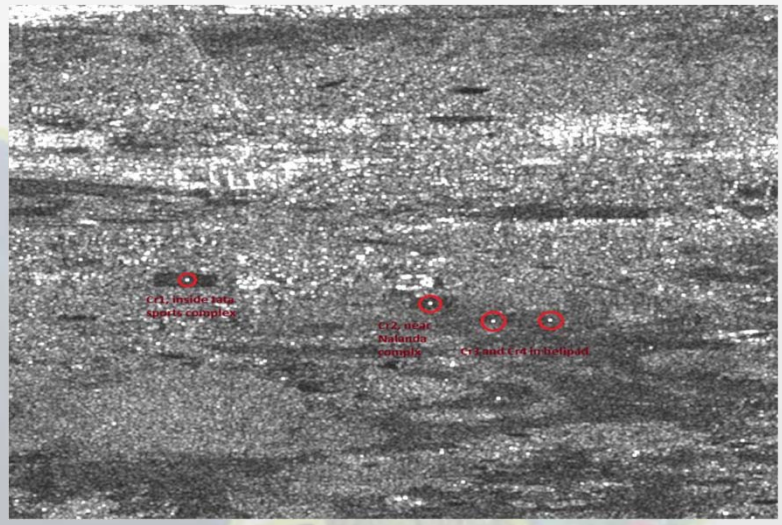
Differential NavIC based precise positioning was done by collecting data using Accord NavIC receivers in base-rover configuration during the campaign at Desalpar to estimate the accurate position of the CRs placed in the field.

CR Deployment in IIT Kharagpur

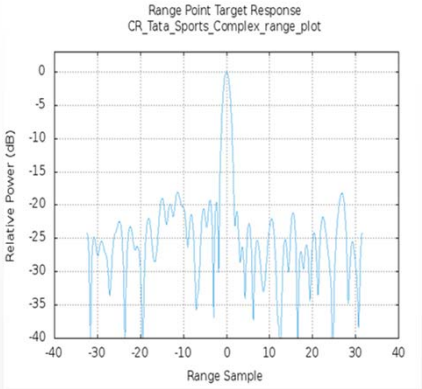
CR 60cm Trihedral

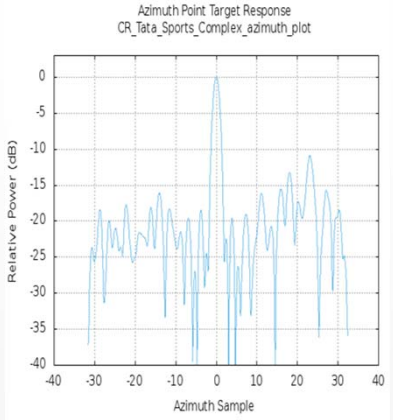


CR 90cm Trihedral



Sentinel-1A image over Kharagpur on 5th April 2018

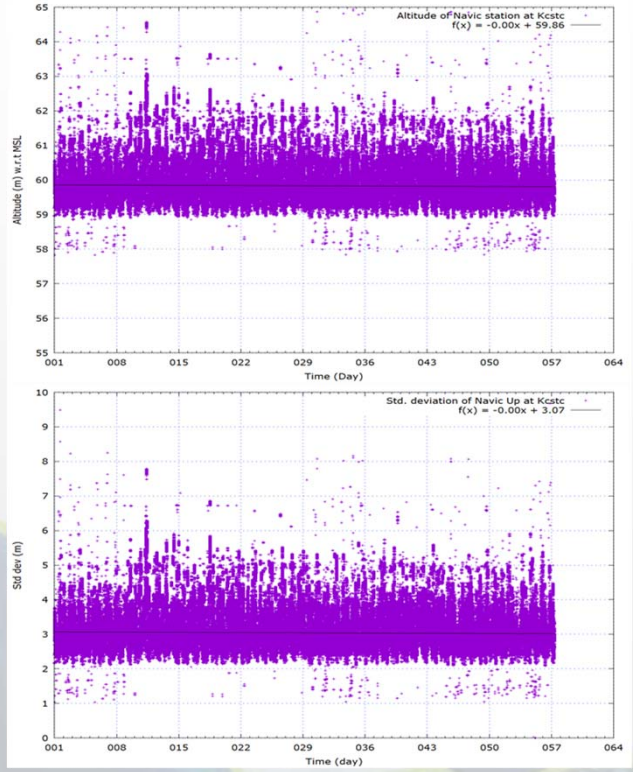




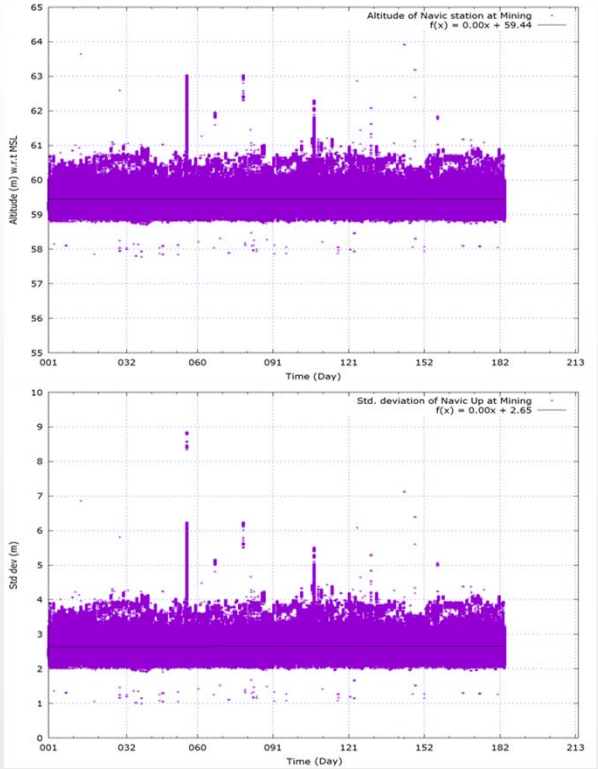
CR No.	Range		Azimuth	
	PSLR (dB)	***ISLR (dB)***	***PSLR (dB)***	***ISLR (dB)***
CR-1	-18.008	-14.251	-10.952	-12.945
CR-2	-13.643	-14.709	-3.230	-13.784
CR-3	-15.280	-11.906	-12.769	-10.306
CR-4	-13.913	-11.445	-15.622	-11.078

NAVIC RECEIVERS Analysis

Plot of NAVIC at KCSTC, IITKGP



Plot of NAVIC at Mining Dept, IITKGP

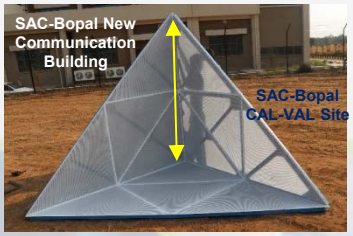


NAVIC Station name	MSL height (m)	Std-dev of height (m)	Std-dev of North (m)	Std-dev of East (m)
Mining Dept.	59.44	2.65	1.27	1.01
KCSTC	59.86	3.07	1.38	1.09

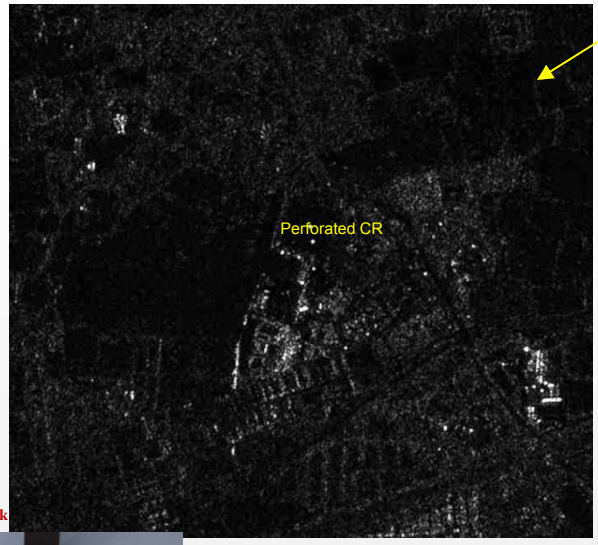
Calibration targets

Detachable Panels

Assembled 2m Perforated CR



Perpendicularity Check

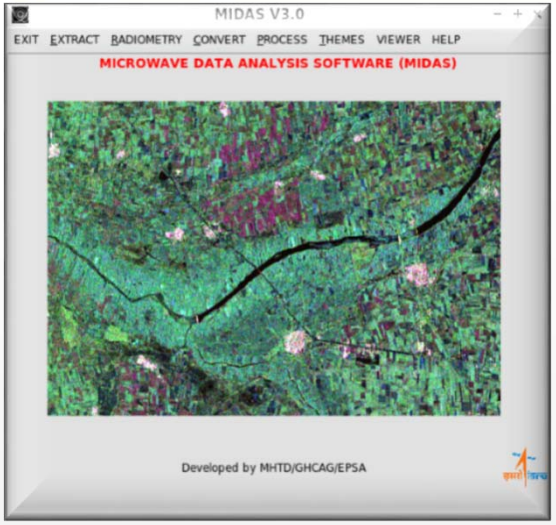


Response of perforated CR in L-band

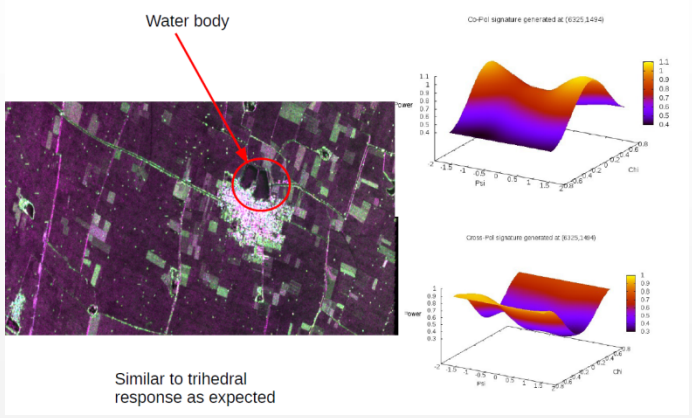
Deployed Perforated CR

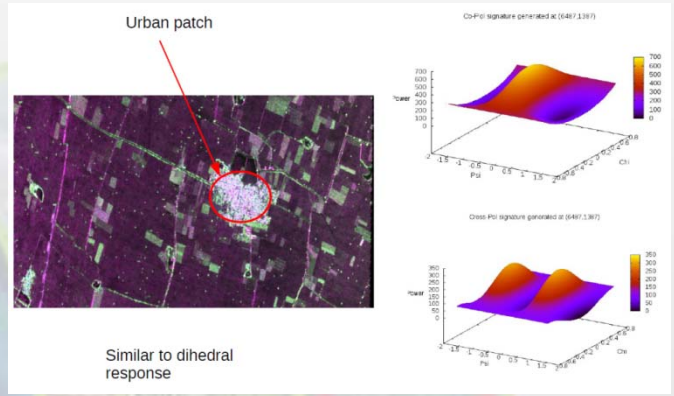
		Date-14-Feb-18		
		L Band-SLC		
CR No.	CR Type	Polarisation	Cal. Constant (in dB)	SCR(in dB)
CR1	TTCR (2mPerf.)	HH	46.883	42.0869
CR2	TTCR (2m)	HH	47.39	42.901
CR1	TTCR (2mPerf.)	VV	49.154	41.99
CR2	TTCR (2m)	VV	48.33	44.35

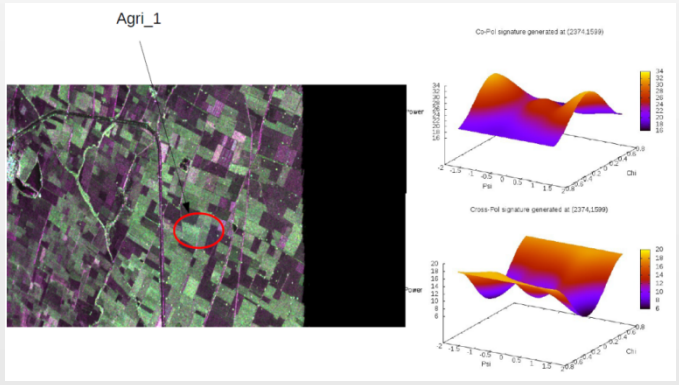
- Development of light weight, detachable CR is in progress
- In-house development of ARC is in progress



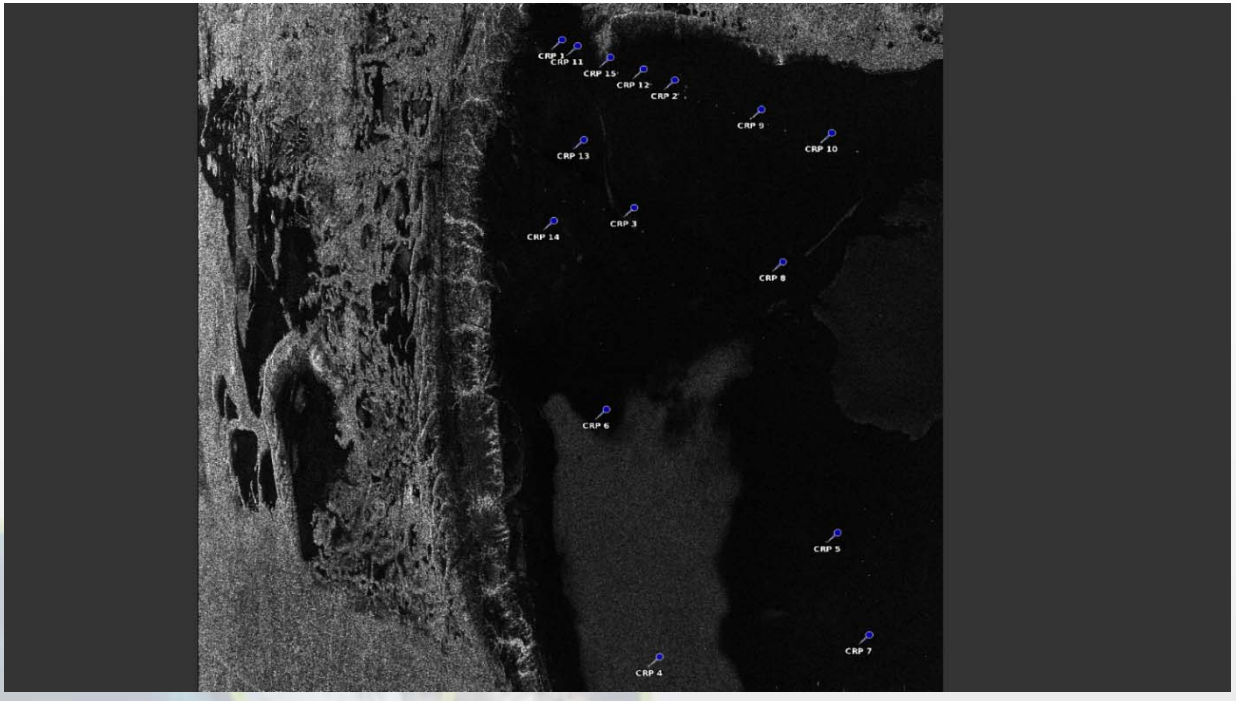
Development of **MI**crowave **D**ata **A**nalysis **S**oftware (MIDAS) is in progress

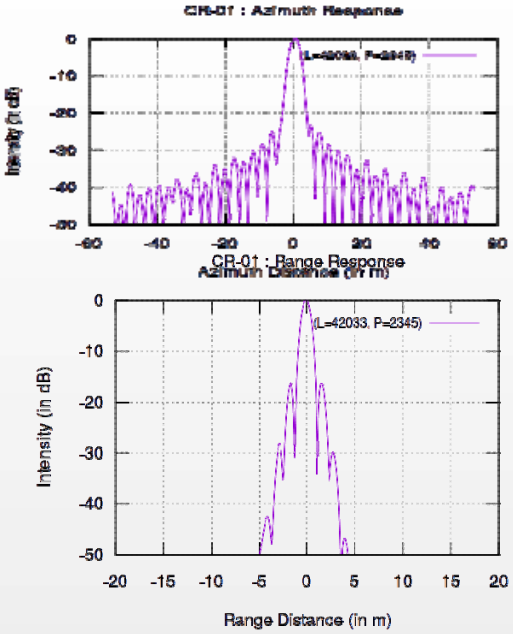




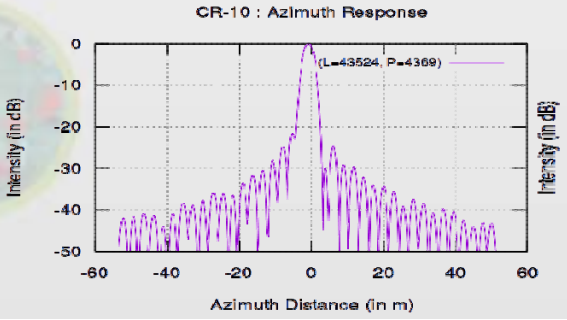


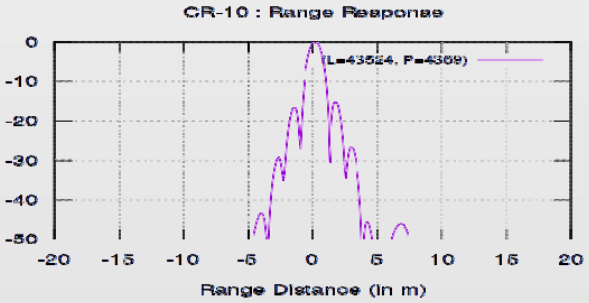
Data Quality Analysis of UAVSAR Data of Rosamond Cal Site using MIDAS



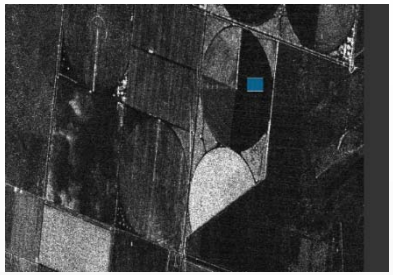
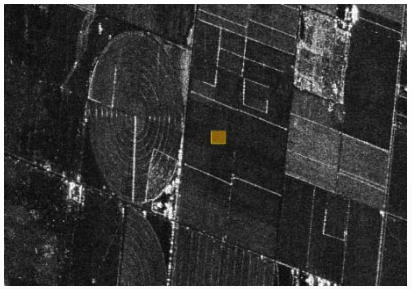
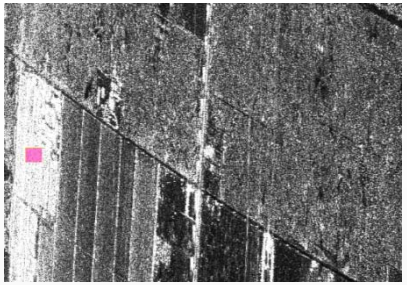


- The DQA is done using MIDAS sw developed at SAC
- This will be used for analysis and cal/val for L& S SAR , RISAT and NISAR data sets .

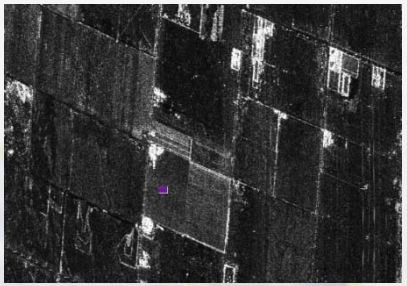
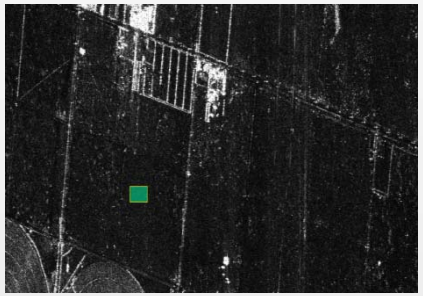
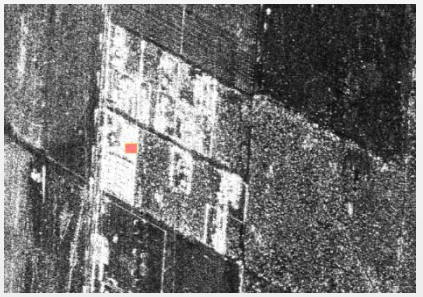




CR No.	Azimuth			Range		
	Resolution (m)	PSLR (dB)	ISLR (dB)	Resolution (m)	PSLR (dB)	ISLR (dB)
01	3.03	-23.18	-20.26	0.98	-16.36	-15.44
02	3.00	-23.50	-20.18	0.98	-16.14	-15.37
03	2.99	-23.14	-19.73	0.98	-15.53	-15.17
04	3.04	-24.43	-20.56	0.98	-15.27	-15.03
05	2.93	-20.04	-18.67	0.97	-15.19	-14.71
06	3.00	-24.90	-20.23	0.97	-15.70	-14.96
07	2.92	-21.99	-18.83	0.96	-15.50	-14.63
08	2.93	-22.48	-18.73	0.96	-15.29	-14.44
09	2.99	-21.13	-19.20	0.98	-15.60	-14.84
10	2.98	-21.56	-19.65	0.98	-15.11	-14.76

Mean_intensity	8.2x 10^8	8.4x 10^8	8.3x 10^8
Rad_Res (dB)	3.30	3.32	3.35

Mean_intensity	8.41x 10^8	8.4 x 10^8	8.18 x 10^8
Rad_Res (dB)	3.31	3.36	3.40

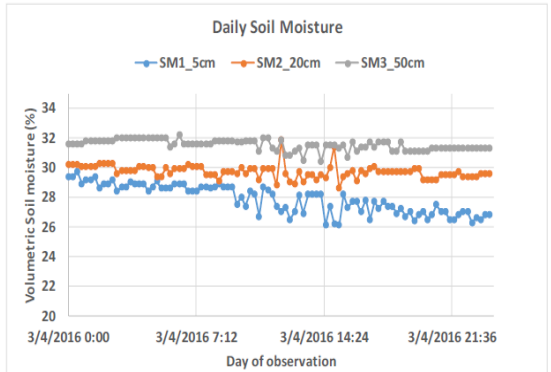
Radiometric analysis of UAVSAR data using MIDAS

Soil Moisture Calibration Validation

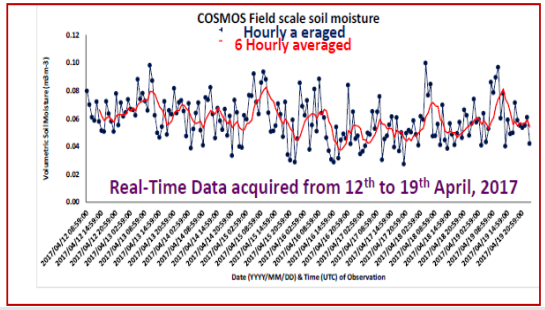
- Pan India deployment of Hydraprobe stations has been initiated. 1 COSMOS station also installed.
- COSMOS at AAU grounds. Hydraprobes in Karnataka, Madhya Pradesh, Kharagpur and Varanasi completed. Next Jaisalmer and Delhi regions are planned.
- Regular SM data are being used for model development and validation of SAR and SMAP derived Soil Moisture.

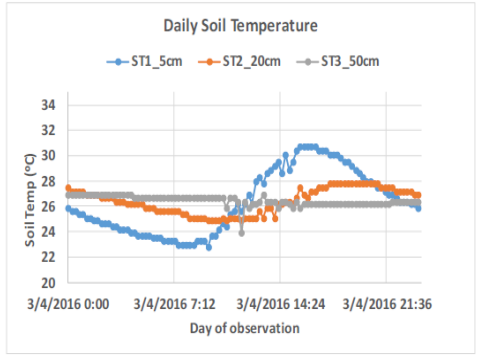
Validation of satellite derived soil moisture using in-situ point observation

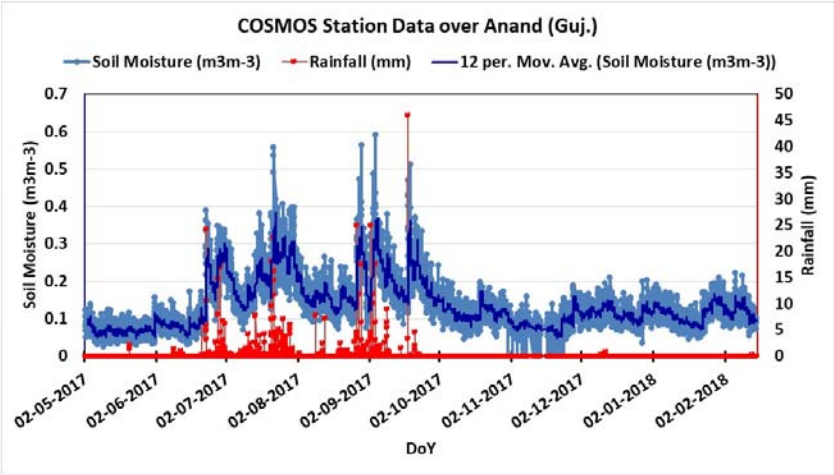
- Portable mobile soil moisture probes
- Automated hydra probe stations

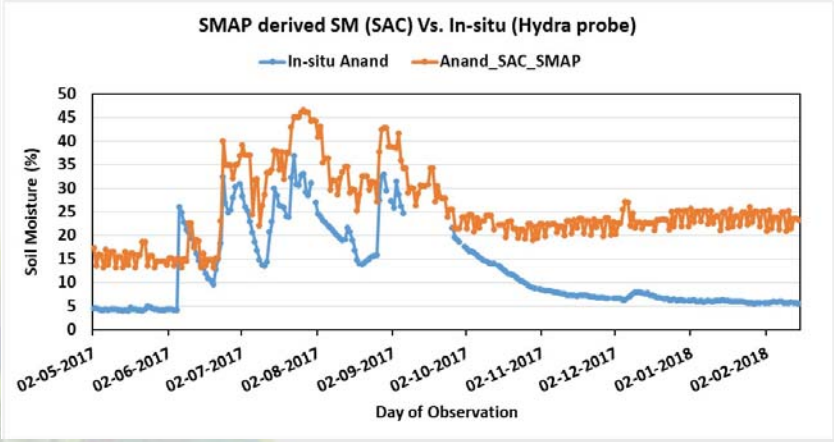


- COSMOS: COsmic-ray Soil Moisture Observing System









Time series analysis for 2017-2018, There is good trend followed by SM products (SAC), matching with in-situ SM (hydra probe and COSMOS). There is systematic bias which need to be corrected, separately for dry and wet periods.

SCATSAT Calibration and Validation

(Latest data V1.1.3 was made operational this March at NRSC)

Major Observations

The slice level balancing for both inner and outer beams look perfect.

The noises in L2A sigma-0 are absent.

Over Amazon, Greenland and Antarctica look biases and pass biases are stable and within desired range of 0.25-0.3 dB.

The BT seems to be stable over the calibration targets.

For Wind speed the RMSE are less than 0.9m/s and the directional errors are approx. 15 deg.

Conclusion:

SCATSAT is a quantum jump over OSCAT in terms of quality. Its quality replicates the QuikSCAT in many aspects.

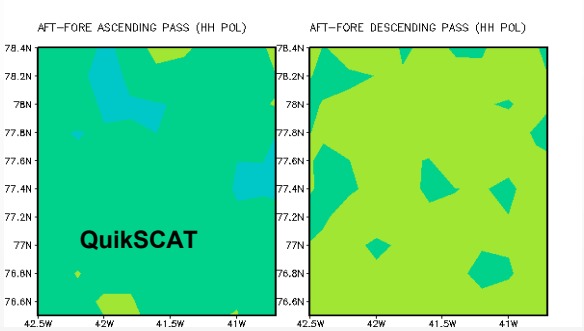
As off now SCATSAT's health is nominal.

The SCATSAT data is having a perfect slice balancing.

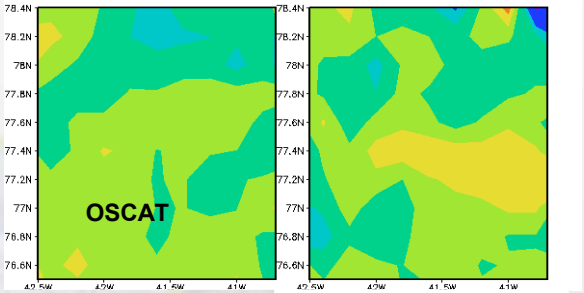
The look biases and pass biases are within mission requirement and approaches the climate quality.

The sigma-0 and other parameters are stable over global invariant sites.

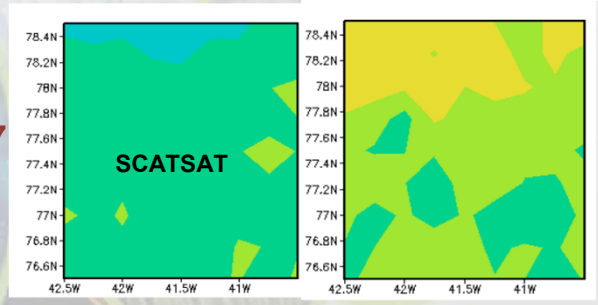
Nov -2009



Nov -2009



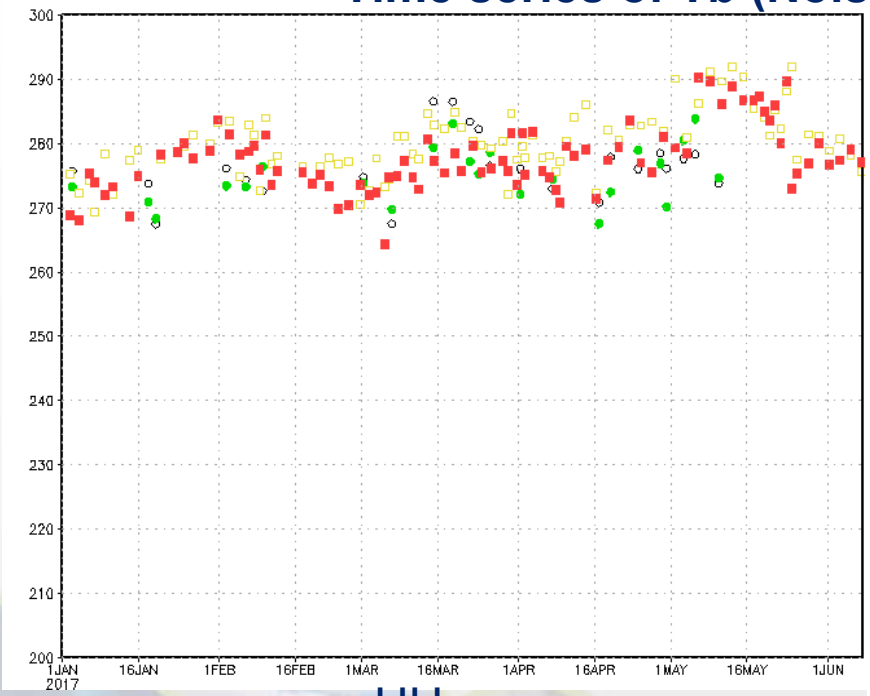
01Jan-04Jul 2017



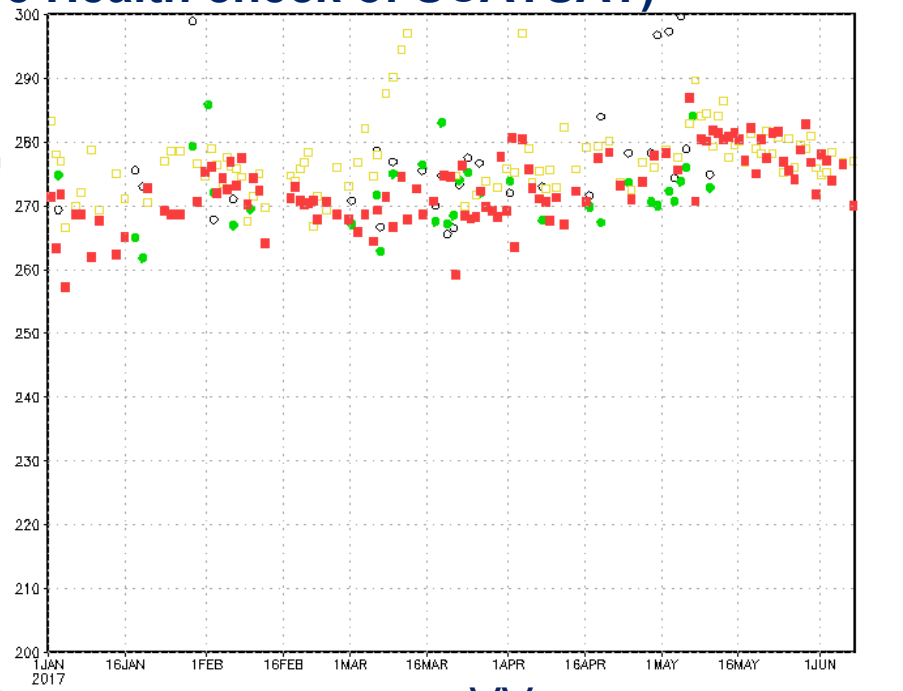
Comparative analysis of Quikscat-OSCAT-SCATSAT sigma-0 look biases over Greenland calibration site

The look biases in SCATSAT is largely improved over OSCAT mission due to improved slice level balancing and is comparable to QuikSCAT reference mission.

Time series of Tb (Noise Health check of SCATSAT)



HH



VV

Variation of BT over Amazon from 001-0185 JD of 2017 (1st Jan- 4th July 2017)

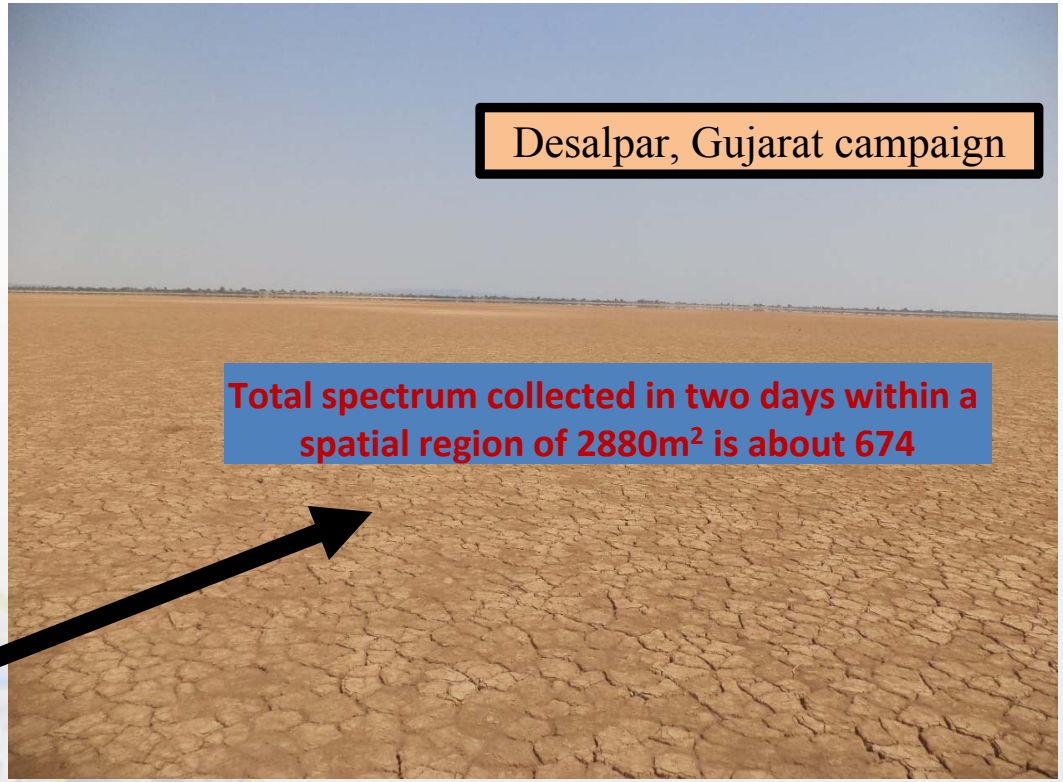
Tb looks stable over the calibration target.

Seasonal variability in Tb is seen which is expected.

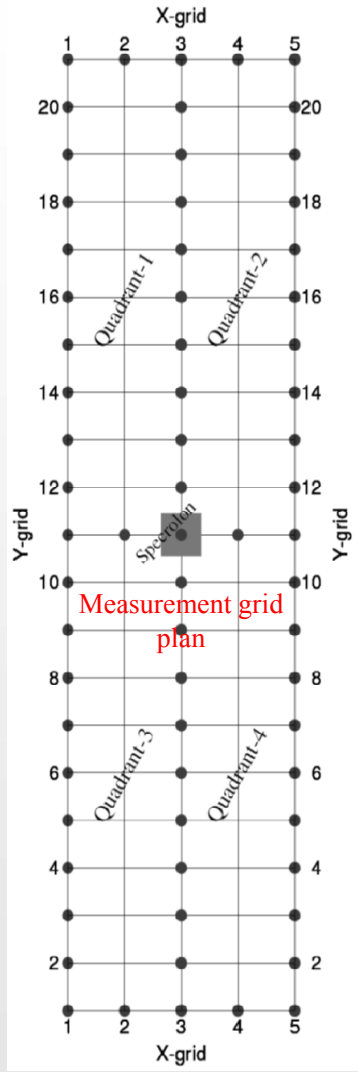
Mild rising trend is noticed (~2K).

AVIRIS-NG Calibration

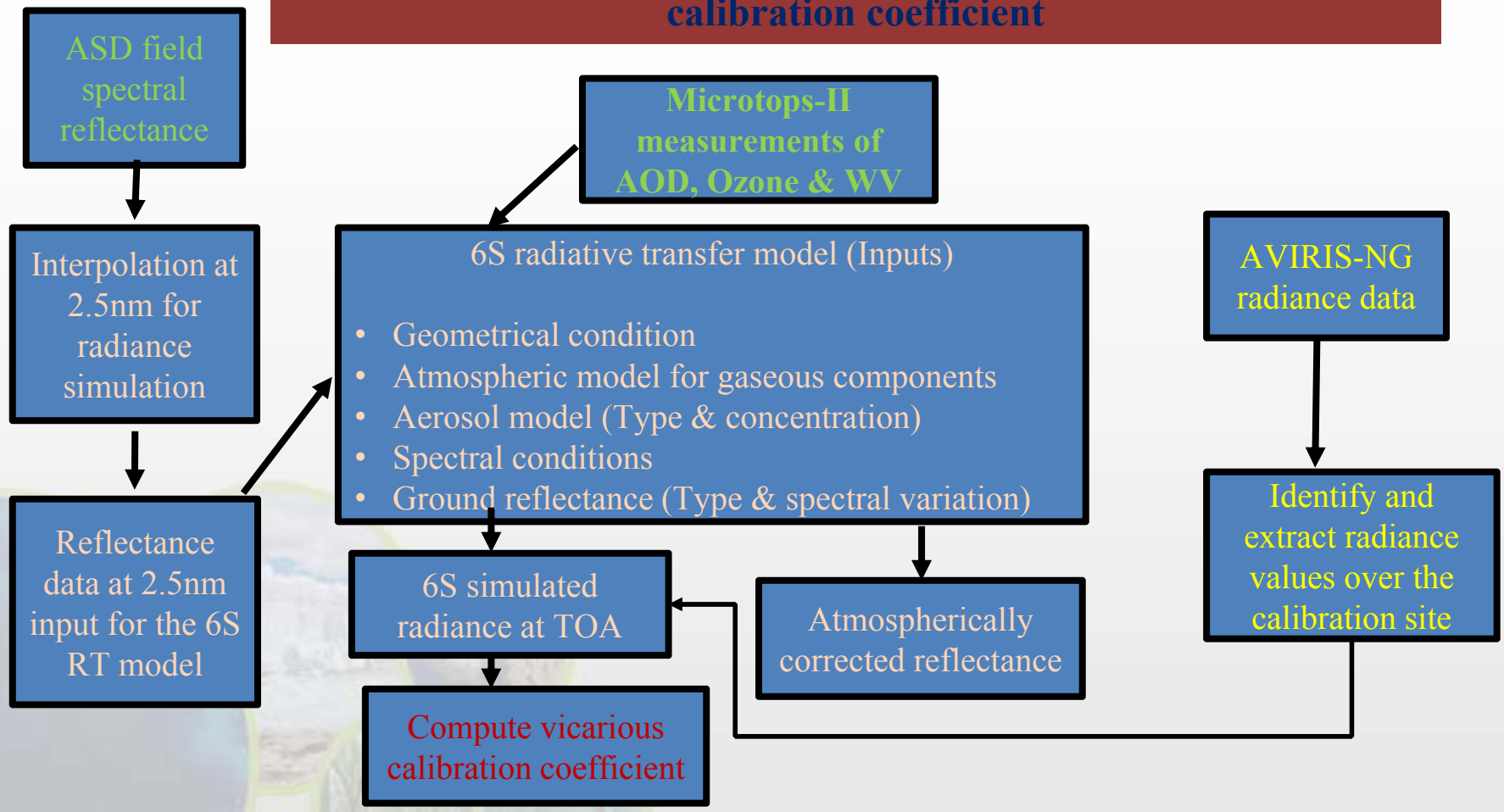
AVIRIS Image Phase I (10th Feb. 2016)

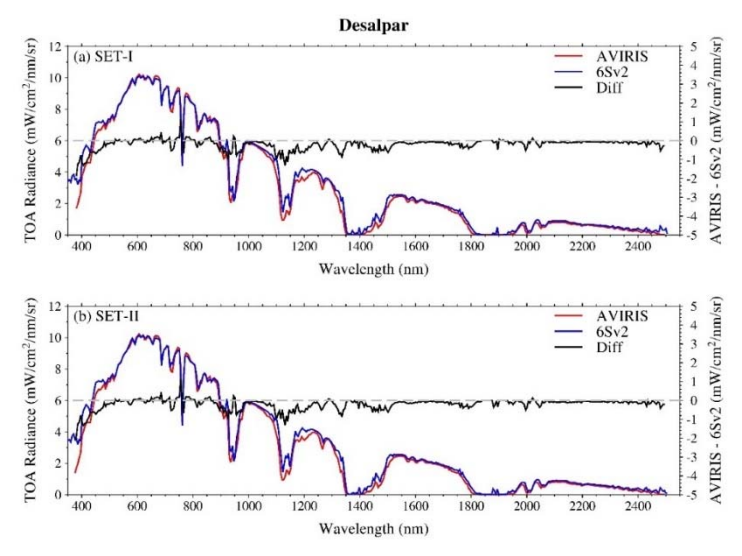


Sky condition



Flow chart for the simulation of TOA radiance and vicarious calibration coefficient





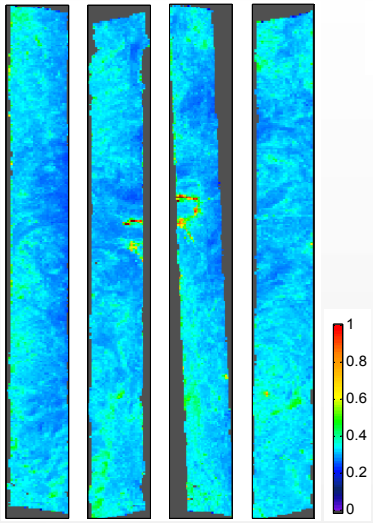
- Spectral range: 0.38-2.5 µm, ~5.2nm bandwidth
- Nos of channels : 425
- Flight Alt : (4-8Km
- Spatial resoln: 4-8m
- Swath: 2-3 Km, Along track 8-10Km

- Instruments:
- ASD, Sunphotometer, Ozonometer

- The ARIVIS-NG sensor calibration exercises have been carried out at Desalpar calibration site.
- The spectral vicarious calibration gains are within 5% with respect to model simulation.
- The 3-4% total RMSE is found for the full range at Desalpar.
- The site is dominated by absorbing aerosol in general during winter season.

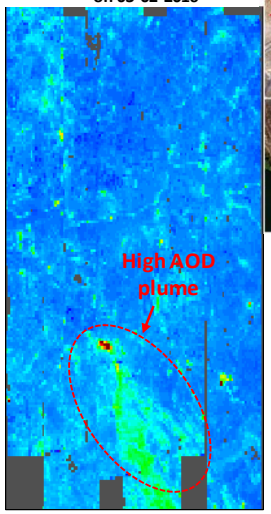
Aerosol Optical Depth (AOD) retrieval from AVIRIS-NG L1 Data

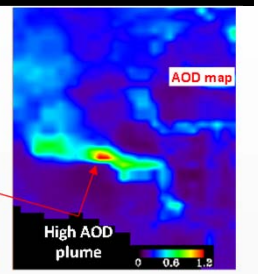
AOD (550nm) over Ambaji on 02-02-2016

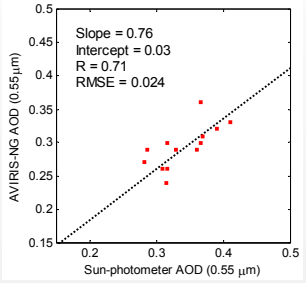


High AOD plume is due to fine particles suspended in atmosphere in region affected by MAHI cement industry

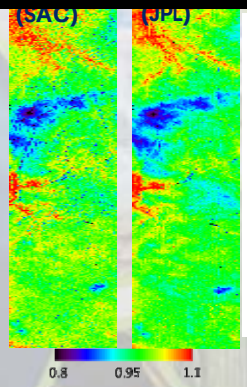
AOD (550nm) MOSAIC over Bhuki on 03-02-2016

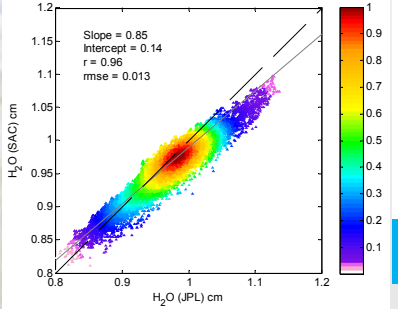




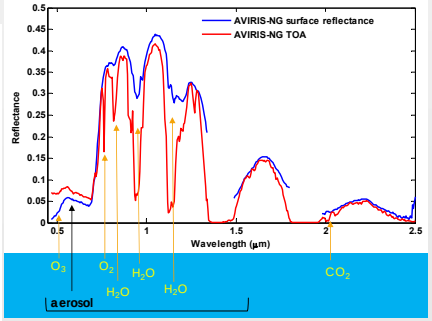


Water vapour (Ambaji) from AVIRIS-NG L1 Data

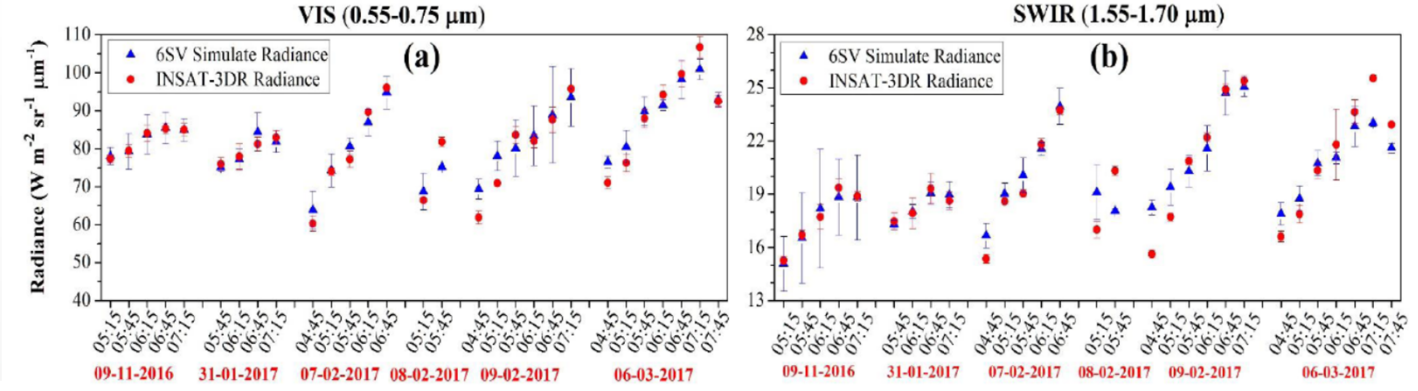


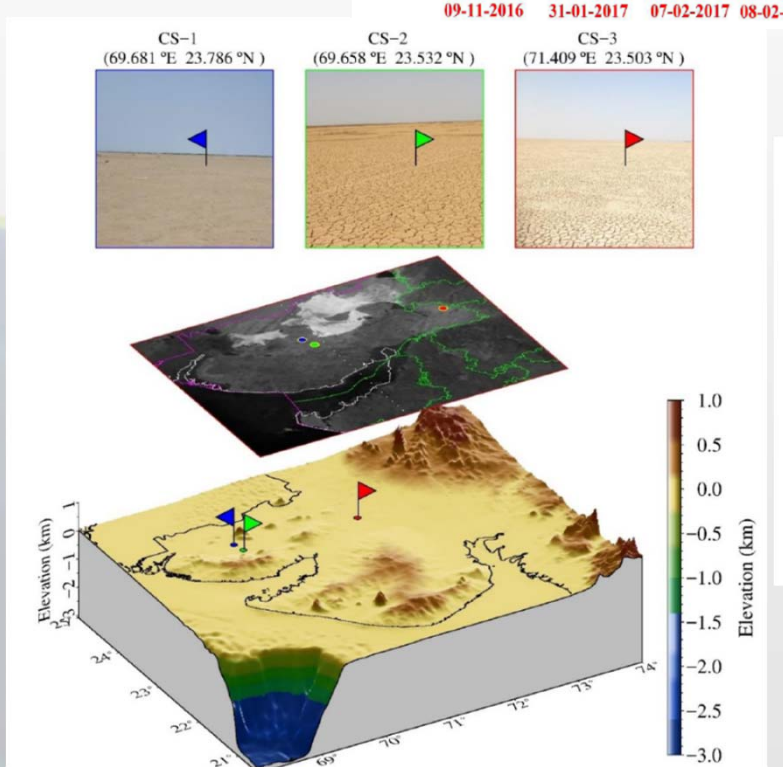


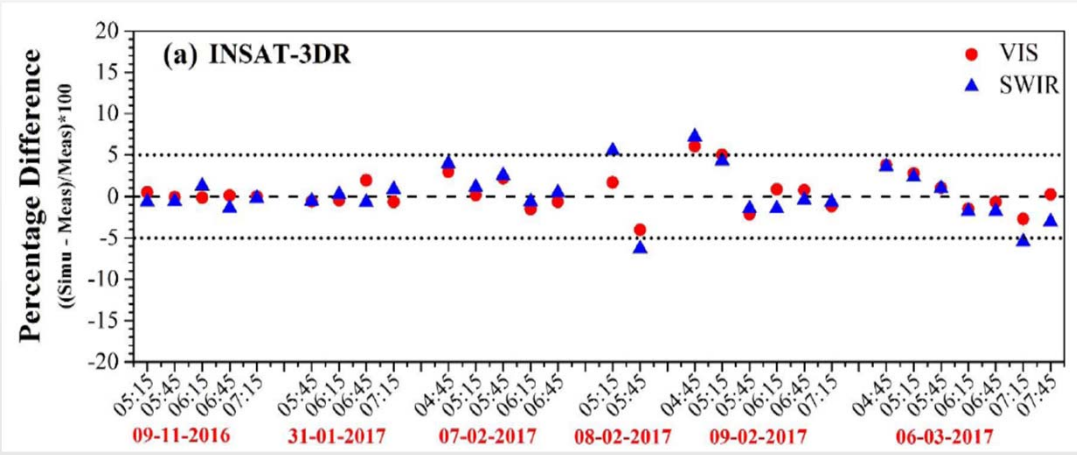
Effect of Aerosols & gas absorption correction



INSAT-3DR vicarious calibration for visible (0.55 – 0.75um)and SWIR (1.55 – 1.70um)channels








THANK YOU