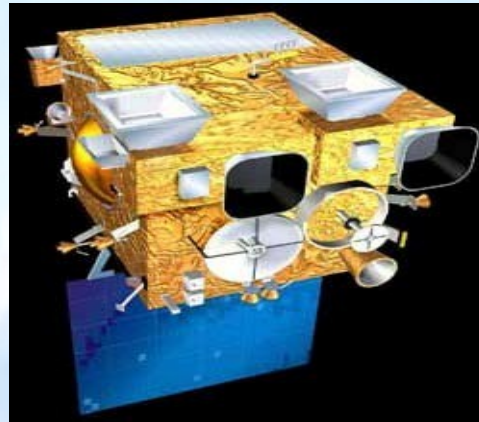


# IMD Agency report for GSICS GRWG and GDWG meeting, 2016



Contributors: A.K Sharma and A.K Mitra



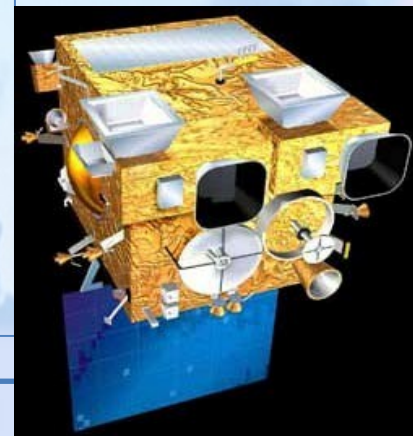
# Current Indian Geo stationary Meteorological satellites

At present the following three INSAT satellites are in operation

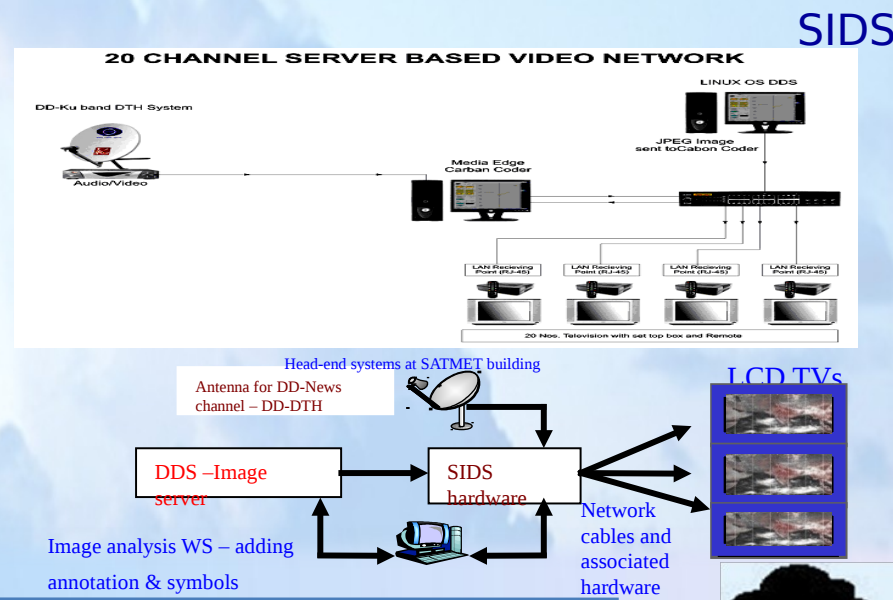
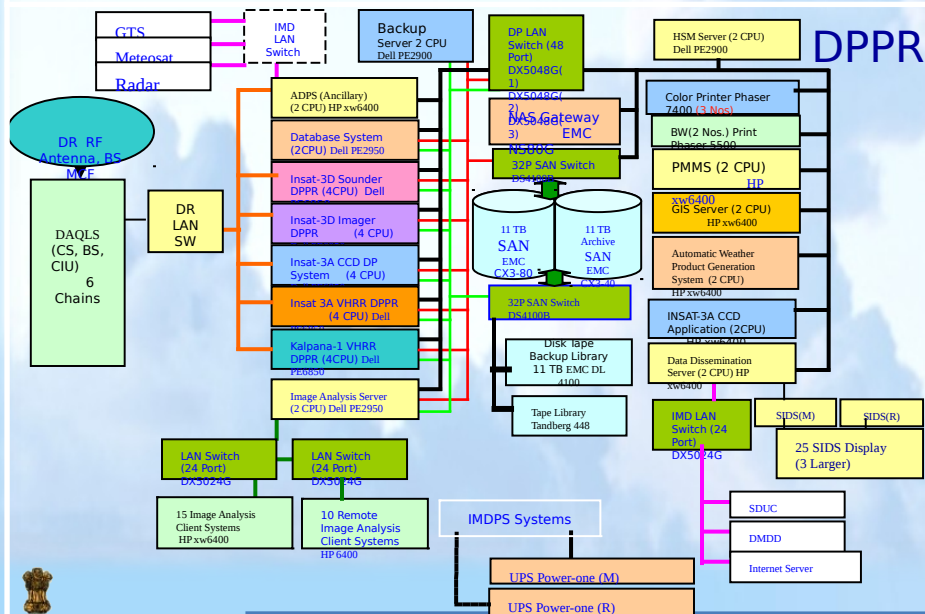
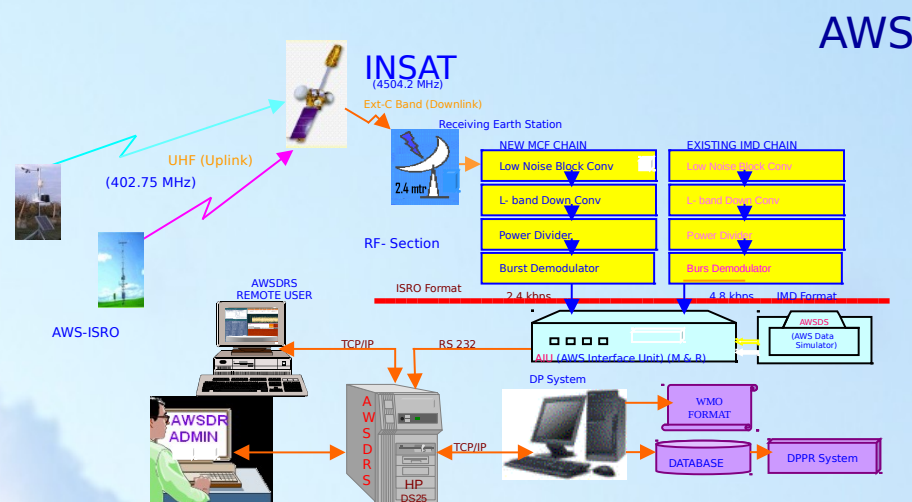
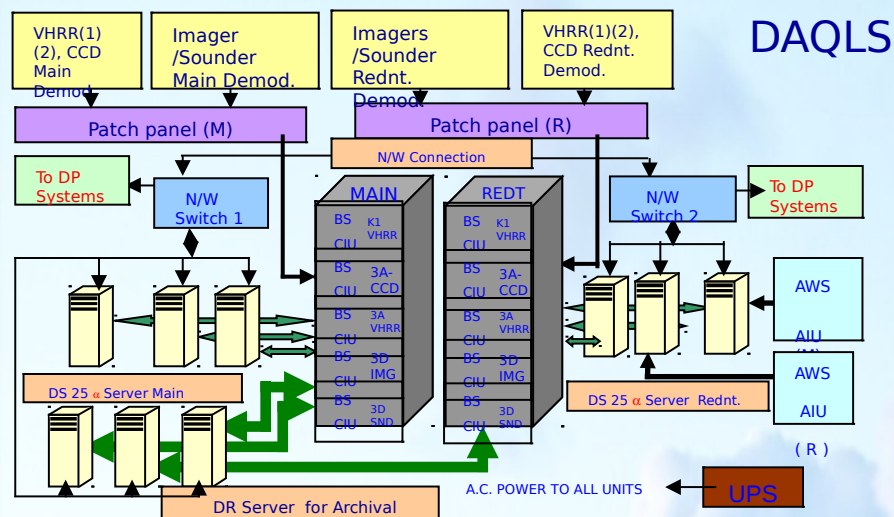
**Kalpana -1(METSAT)** is a meteorological satellite which was launched in September 2002. It is located at  $74^{\circ}$  east. For meteorological observation, METSAT carries a Very High Resolution Radiometer (VHRR) capable of imaging the Earth in the visible, thermal infrared and water vapor bands. It also carries a Data Relay Transponder (DRT) for collecting data from unattended meteorological platforms.

**INSAT-3A** is a geostationary satellite which was launched in April 2003. It is located at  $93.5^{\circ}$  east longitude in the geostationary orbit. INSAT-3A is the third satellite in the INSAT-3 series. INSAT-3A is a multipurpose satellite for providing telecommunications, television broadcasting, meteorological (VHRR, CCD, DRT) and search & rescue services.

**INSAT-3D** is India's advanced weather satellite and was launched in the early hours of July 26, 2013 from Kourou, French Guiana, and has successfully been placed in Geosynchronous orbit. It is a dedicated meteorological satellite and carries four payloads: Imager (Six Channels), Sounder (Nineteen Channels), Data Relay Transponder (DRT) & Satellite Aided Search and Rescue (SAS & R). It is located at  $82^{\circ}$  degrees east.

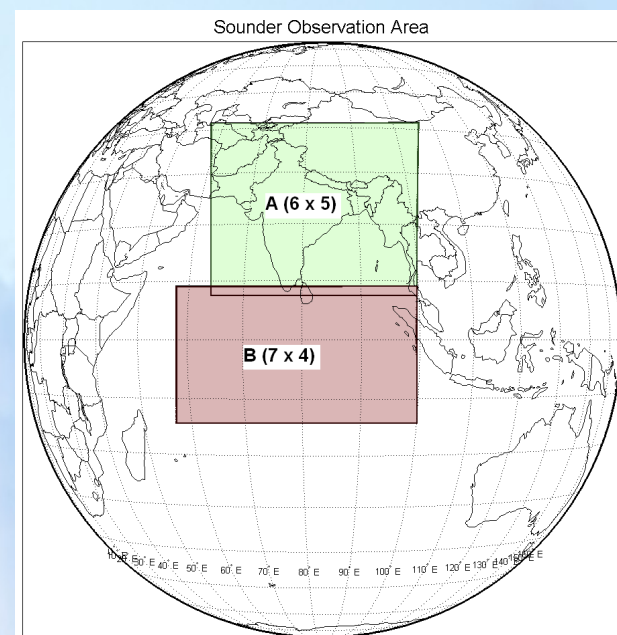


# Satellite data receiving Ground Segment



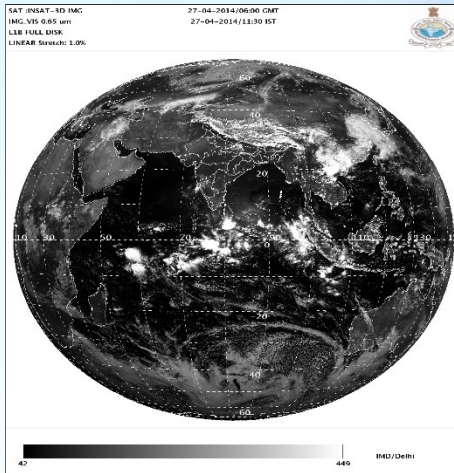
The present system was installed in 2008-09.  
Used for processing and dissemination of data from all the three currently operational Geostationary satellites(Kalpana-1, INSAT-3A & INSAT-3D).

INSAT Series	Temporal Resolution
K1-VHRR	Half Hourly( 0015 & 0045 UTC)
3A -VHRR	Hourly
3A- CCD	3,5,6,7,9,11 UTC
3D -Imager (6 Channel)	½ hourly (0000 & 0030 UTC)
3D -Sounder (19 Channel)	Hourly (Five times Region-A and sixth times region-B)

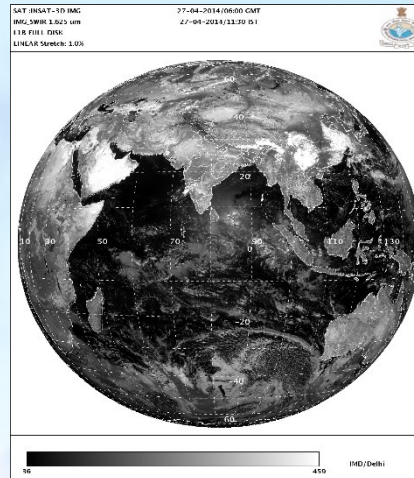


# INSAT-3D Imager

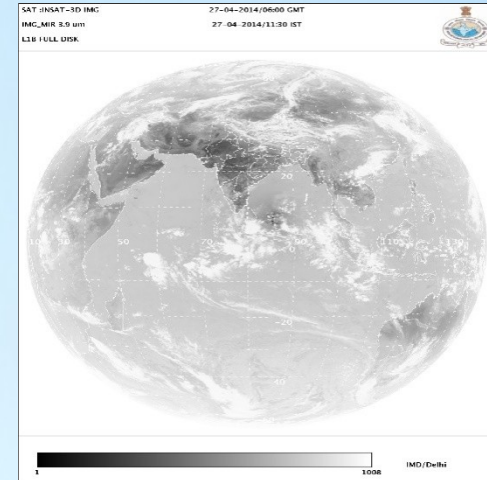
## Standard Products (L1B) viewed on 27 APR 2014 at 0600 UTC



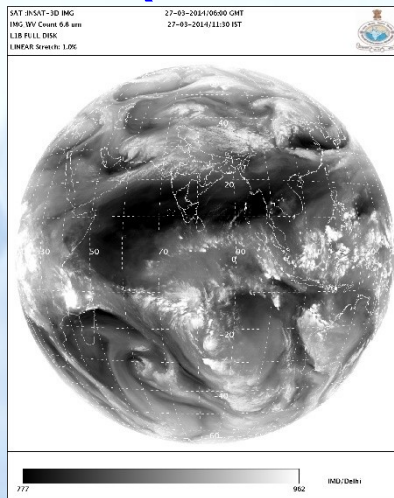
**VIS (0.55-0.75µm)**



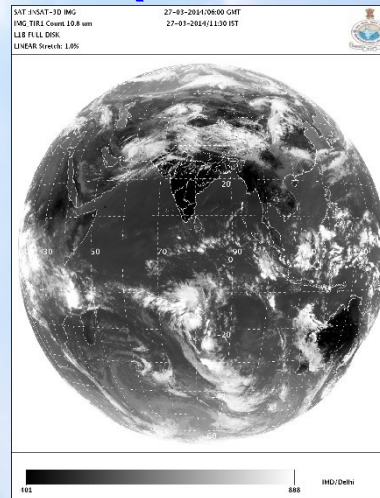
**SWIR(1.55-1.70µm)**



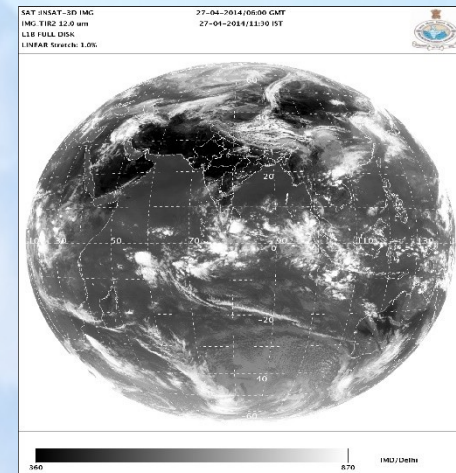
**MIR(3.80-4.00µm)**



**WV(6.50-7.10µm)**



**TIR-1(10.30-11.30µm)**



**TIR-2(11.50-12.50µm)**



# INSAT-3D Imager Products types and formats .

1	Outgoing long wave radiations	L2B/L 3B	OLR	HD F	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly)	WV, TIR-1, TIR - 2
2	Rainfall using Hydro Estimator	L2B/L 3B	HEM	HD F	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly )	TIR-1, TIR- 2
3	FOG	L2C/L 3C	FOG	HD F	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly )	SWIR, MIR, TIR-1, TIR-2
4	SNOW	L2C/L 3C	SN W	HD F	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly )	VIS, SWIR, TIR - 1, TIR -2
5	Cloud Mask	L2B/L 3B	CMK	HD F	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly)	MIR, TIR-1, TIR-2
6	Upper Troposphere Humidity	L2B/L 3B	UTH	HD F	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly )	WV, TIR-1, TIR - 2
7	Sea Surface Temperature	L2B/L 3B	SST	HD F	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly )	MIR,TIR -1,TIR -2
8	Land Surface Temperature	L2B/L 3B	LST	HD F	Per Pixel(Half hourly ,Daily, Weekly & Monthly )	TIR -1,TIR -2
9	INSOLATION	L2B/L 3B	INS	HD F	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly )	TIR -1,TIR -2



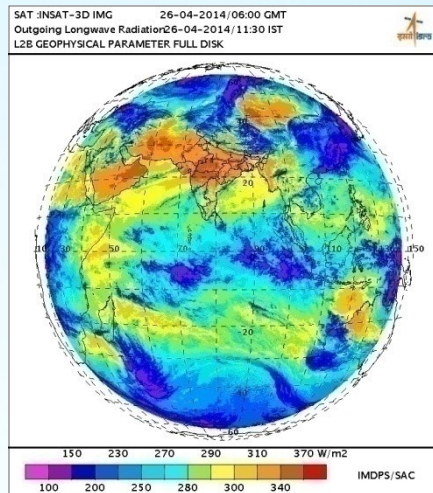
# INSAT-3D Imager Products types and formats Cont .

Geo-Physical Parameters (Point)						
1	FIRE	L2P	FIR	KML	Point	MIR , TIR -1
2	SMOKE	L2P	SMK	KML	Point	VIS, MIR, TIR 1, TIR -2
3	Atmospheric Motion Vectors(VIS/MIR, TIR, WV)	L2P	AMV	HDF	(Point)	VIS, TIR-1, TIR -2 & WV
Geo-Physical Parameters (Gridded)						
1	INSAT Multi-Spectral Rainfall Algorithm (IMSRA)	L2G	IMR	HDF	0.1 deg x0.1 deg (Half hourly ,Daily, Weekly & Monthly )	TIR-1, TIR- 2
2	Quantitative Precipitation Estimation	L2G	QPE	HDF	1 deg x 1 deg (Half hourly ,Daily, Weekly & Monthly )	TIR-1, TIR- 2
3	Aerosol Optical Depth	L2G	AOD	HDF	0.1 deg x 0.1 deg	VIS, TIR -1, TIR - 2

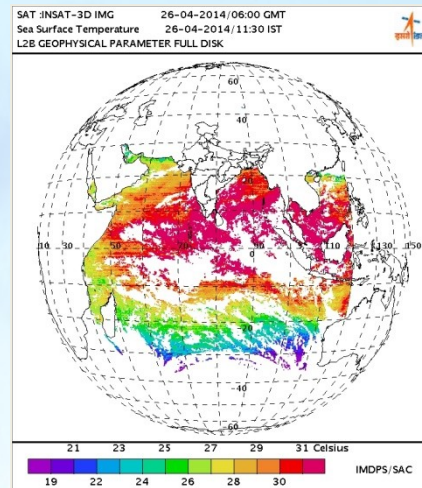


# INSAT-3D Imager

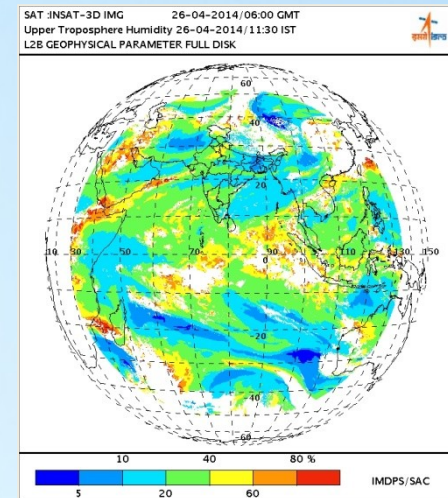
## Geo-Physical Parameters (L2) viewed on 27 APR 2014 at 0600



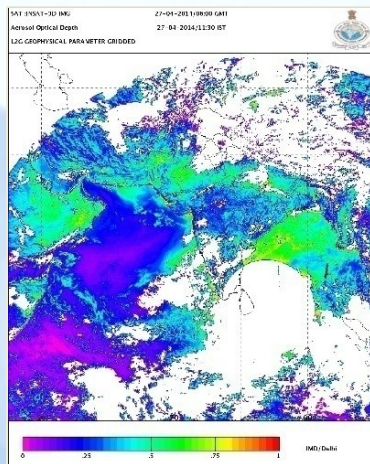
**OLR**



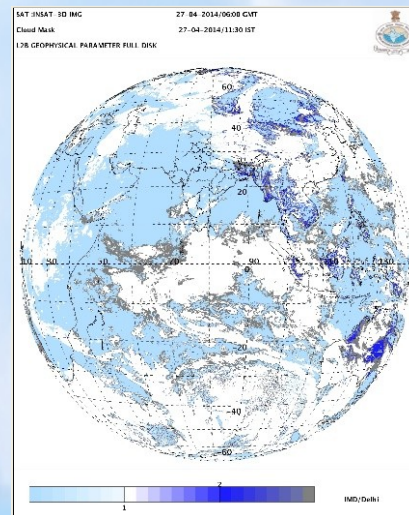
**SST**



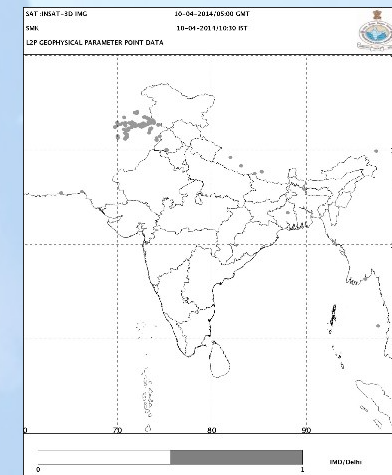
**UTH**



**AOD**



**CMK**



**Smoke**



# FUTURE GEO Imaging SATELLITES: (GISAT)

## Payloads:

### 1. High resolution multi-spectral VNIR (HRMX-VNIR):

Bands:	B1 (0.45 mm - 0.52 mm)	}	50m Res.
:	B2 (0.52 mm - 0.59 mm)		
	B3 (0.62 mm - 0.68 mm)		
	B4 (0.71 mm - 0.74 mm)		
	B5 (0.77 mm - 0.86 mm)		
	B6 (0.845 mm - 0.875 mm)		

### 2. Hyper spectral VNIR:

No. of Bands	: 60 bands in range 0.4 mm to 0.87 mm
Resolution : 320 m	

### 3. Hyper spectral SWIR (HyS-SWIR):

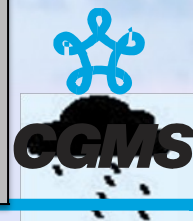
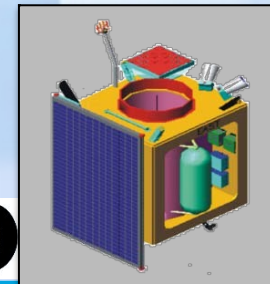
No. of Bands	: 150 bands in range 0.9 mm to 2.5 mm
Resolution : 192m	

### 4. High resolution Multi-spectral (HRMX-TIR):

Bands:	TIR1 (7.1 mm - 7.6 mm)	}	1.5 km Res.
	TIR2 (8.3 mm - 8.7 mm)		
	TIR3 (9.4 mm - 9.8 mm)		
	TIR4 (10.3 mm - 11.3 mm)		
	TIR5 (11.5 mm - 12.5 mm)		
	TIR6 (13 mm - 13.5 mm)		

- Multi-spectral, multi-resolution imager
- Full or part of the earth disk from Geosynchronous orbit.

**Frequent  
Monitoring of  
Coastal &  
Ocean  
Parameters**



# Future Plans

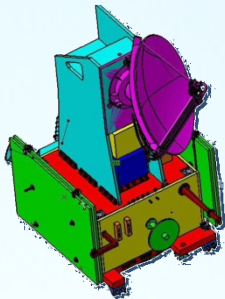
New ground receiving and processing system for presently operational satellite and INSAT- 3DR, INSAT-DS and GISAT satellites, based on major components as given below:

- Earth Station for INSAT-3DR, INSAT-3DS and GISAT.
- Processing and dissemination systems for current and future satellites including AWS/ ARG stations data with provision of 100% redundancy.
- Storage and data archival/ retrieval system of 01 Petabyte (PB) capacity with scalability up to 10 PB along with provision of development of on line visualization and analysis tools on line of [disc.sci.gsfc.nasa.gov/Giovanni](http://disc.sci.gsfc.nasa.gov/Giovanni).
- Integration of existing algorithms developed by SAC, ISRO for Kalpana-1, INSAT-3A & INSAT-3D data processing and derivation of products and development of new algorithms as per IMD requirements.
- Development of new algorithms for data receiving, processing and products retrieval
- Algorithms for GISAT satellite as per IMD requirement.
- The detailed requirement of project will be worked out by joint committee of IMD and ISRO.



# FUTURE LEO SATELLITES: (SCATSAT)

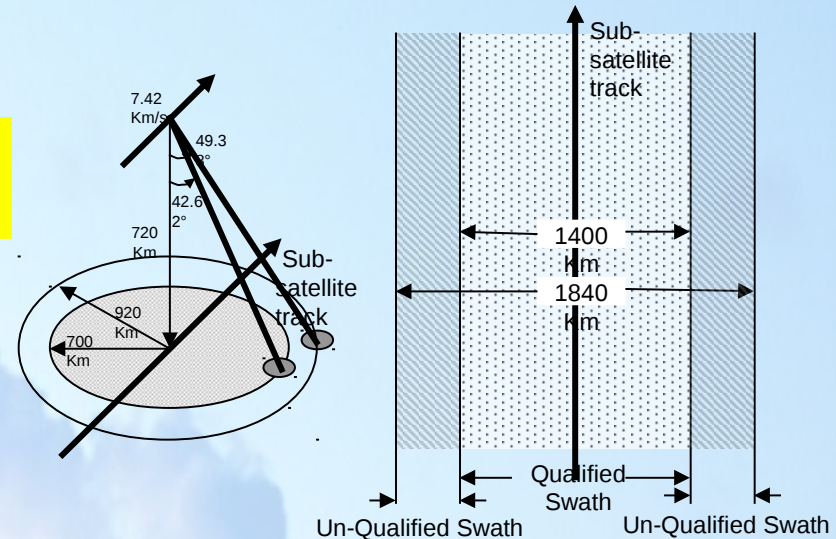
SCATSAT-1 is planned as an in-orbit replacement for the Scatterometer carried onboard Oceansat-2, which is non-functional after 4 ½ years of service.



**Orbit : 720 km in sun-synchronous**

**LAUNCH: End 2016**

- IMS-2 Bus
- Ku-Band (13.515 GHz) Pencil beam Scatterometer
- Ground resolution: 50 km x 50 km
- Swath: 1440 Km
- Polarization: HH and VV
- Wind Direction: 0 to 360 deg with accuracy of 20 deg
- Wind Speed: 4 to 24 m/s with accuracy of 10% or 2m/s



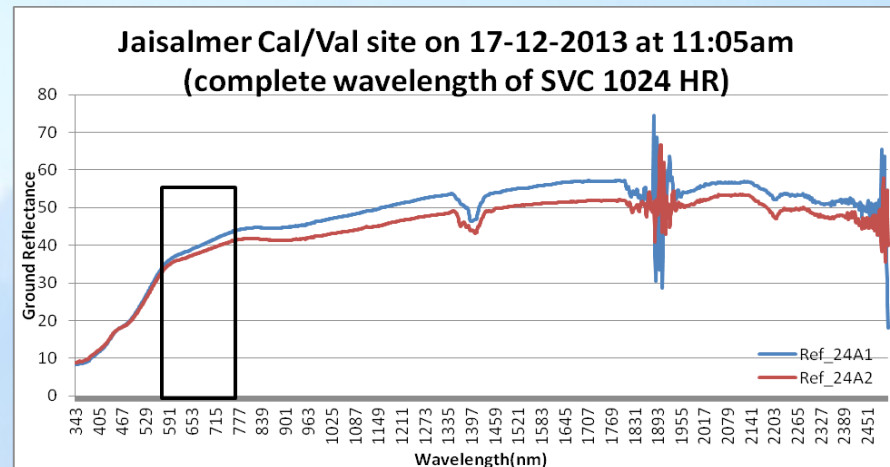
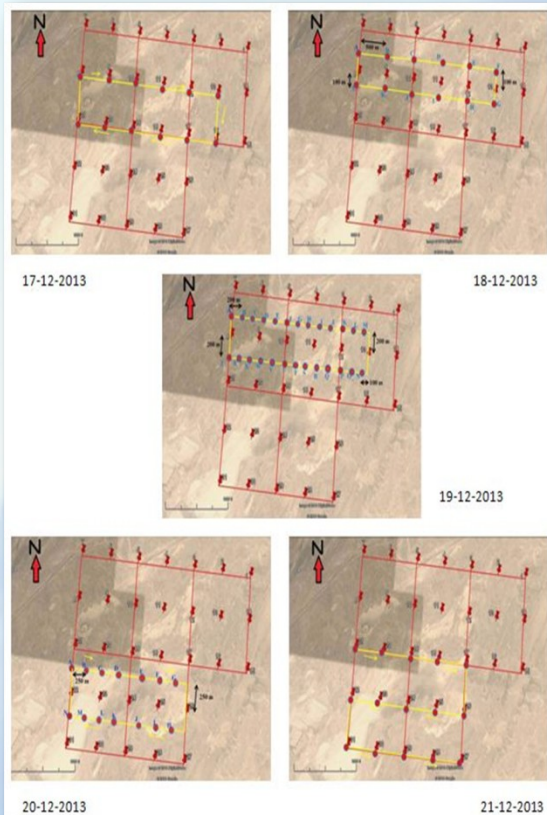
## Objectives:

- To provide global wind vector data for national and international user Community.
- To provide continuity of weather forecasting services to the user communities.
- To generate wind vector products for weather forecasting, cyclone detection and tracking.



# CAL/VAL CAMPAIGN AT JAISALMER

Two successful site campaigns done at Jaisalmer and Bhuj in India during December 2013 and May 2015 respectively.



• **Negative Correlation** has been observed between 6S simulated radiance and INSAT-3D measured radiance as well as pixel wise correlation has not been found good.

• **High variation** in reflectance and less statistical correlation agreement do not satisfy the condition of “Radiometrically uniform calibration site” in its present condition.



# BHUIJ campaign

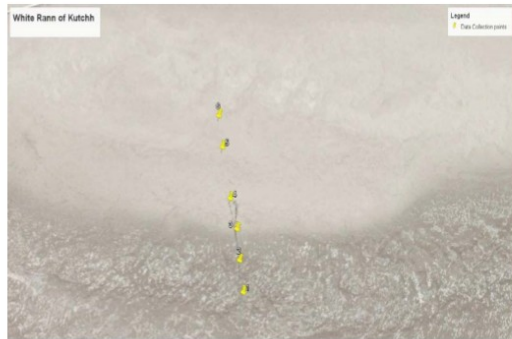


Figure 2: White Rann of Kutch along with data collection points for 01<sup>st</sup> May 2015.

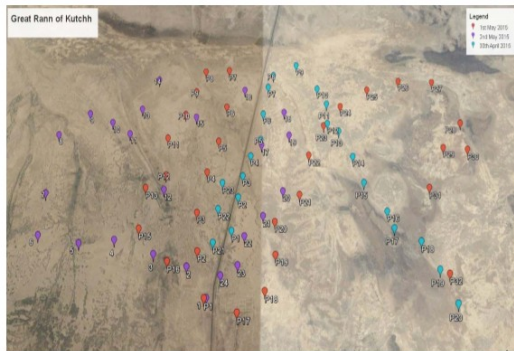


Figure 1: Calibration Site at Great Rann of Kutch including the data collection points.

Work done for the Site suitability for vicarious calibration of imager over Great Rann of Kutch (GROK) for INSAT3D satellite. It was found that site spatial variability was a critical factor in site selection and sensor calibration. The comparison of TOA radiance computed for Visible & SWIR channels over Great Rann of Kutch matches with observed INSAT-3D satellite.

Results show that this site may be selected for ideal Cal/Val site for INSAT-3D satellite. A detailed campaign is planned this year to further characterize the site.

Courtesy: Dr. A.K Mitra, IMD



# PROJECT : INTER-CALIBRATION OF IMAGER OBSERVATIONS FROM TIME-SERIES OF GEOSTATIONARY SATELLITES (IOGEO),SCOPE-CM.

The major objective of this SCOPE-CM (Sustained and Coordinated Processing of Environmental Satellite data for Climate Monitoring) project is the generation of a Fundamental Climate Data Record (FCDR) of calibrated and quality-controlled geostationary sensor data.

The FCDR will contain the visible, IR window and water vapour absorption channels of geostationary satellites. It is proposed to utilise the inter-satellite methodology developed by GSICS to tie existing time series of satellite data to the best reference available in space.



# PROJECT PARTNERS

The IOGEO project team composition at the end 2014 is as follows:

1. EUMETSAT (Darmstadt, Germany) Rob Roebeling, Tim Hewison, Alessio Lattanzio, and Viju John
2. EUMETSAT CM SAF, DWD (Offenbach, Darmstadt) Marc Schröder
3. JMA (Tokyo, Japan) Masaya Takahashi
4. NOAA's NCDC (Asheville, NC, US) Kenneth Knapp, Anand Inamdar
5. CMA NSMC (Beijing, China) Peng Zhang, Xiuqing Hu
6. IMD (Delhi, India)\* **A.K Sharma, Ashim Mitra**



# INSAT-3D INTER-CALIBRATION WITH NOAA19 AND METOP-A

**Area :                60E to 90E  
                         -10S to 50N**

**Time Difference: 10 minute**

**Criteria: Co-located**

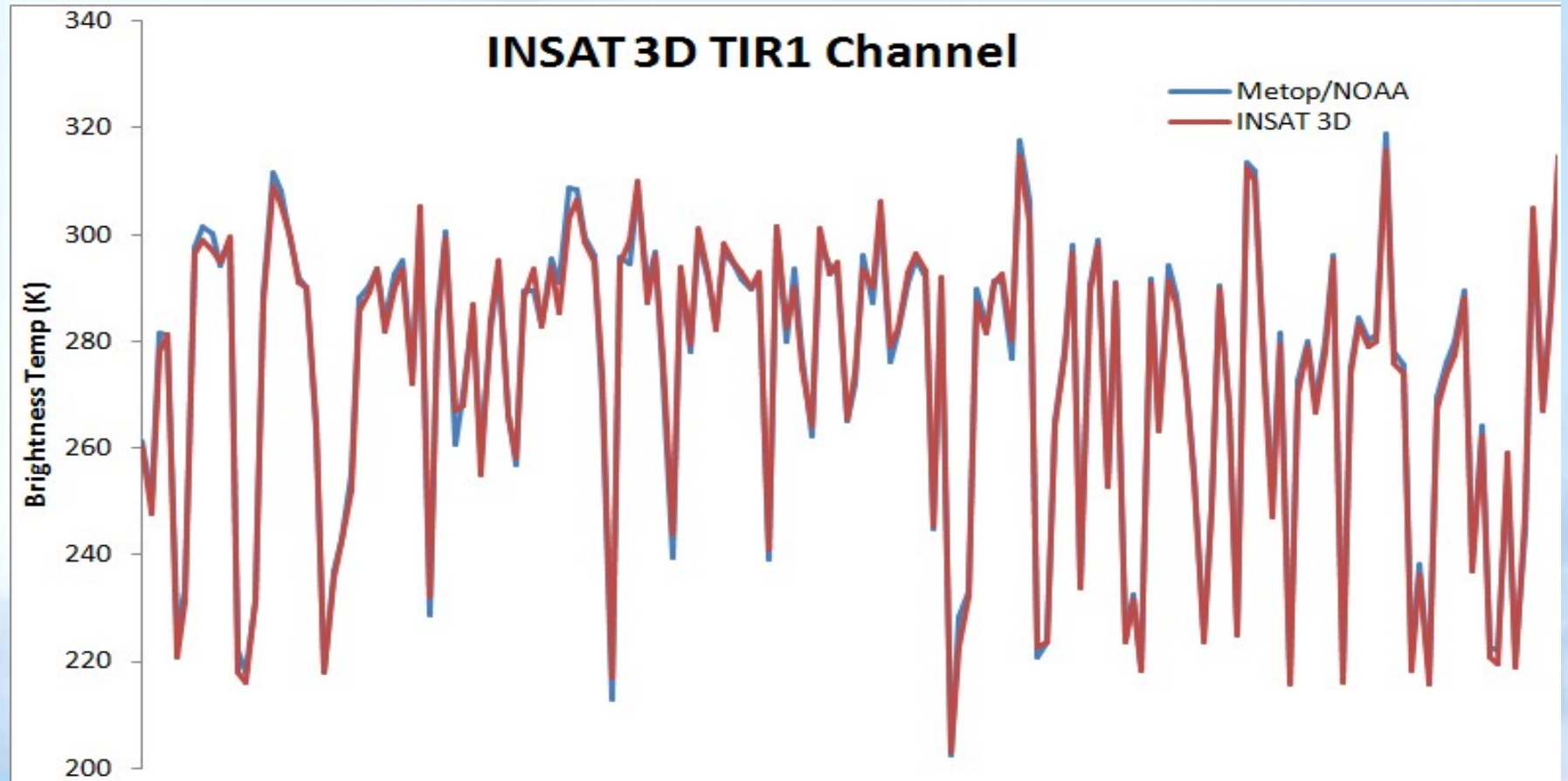
**Observations/Passes: 0600 to 0900 UTC**

*Courtesy: Dr. A.K Mitra, IMD*



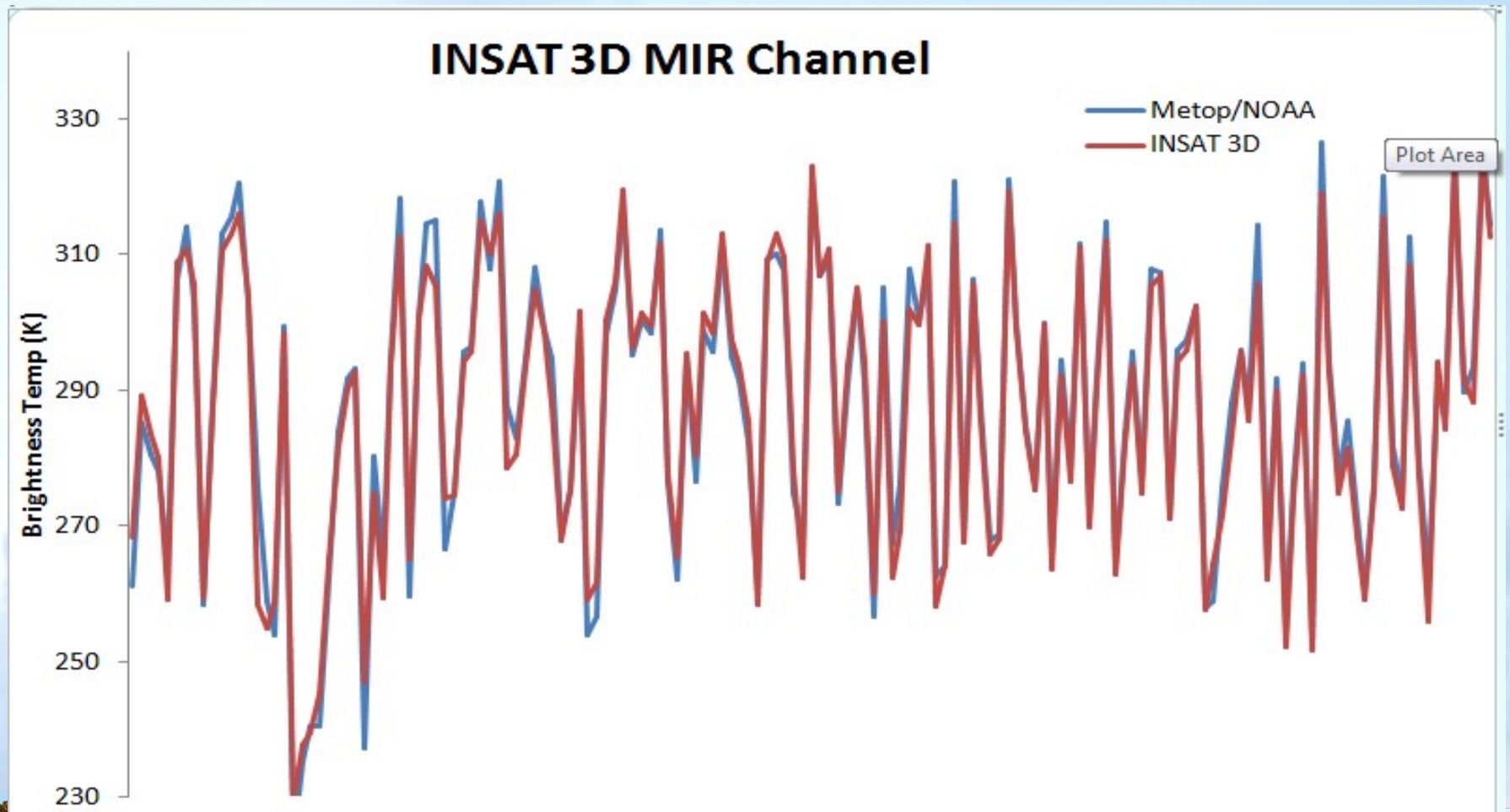
# COMPARISON OF INSAT 3D TIR1 CHANNEL (10.3 UM - 11.3UM) WITH NOAA / METOP TIR1 CHANNEL

FEB 2015



# COMPARISON OF INSAT 3D MIR CHANNEL (3.8 UM - 4.0UM) WITH NOAA / METOP MIR CHANNEL

FEB 2015



# FINDINGS

❖ From the analysis we can conclude that INSAT 3D channels ( MIR and TIR1 Channel) predicts the brightness temperature colder as compared to NOAA/ METOP channels. In addition, INSAT 3D TIR1 channel has an average of **2.5K BIAS** in the month of FEB 2015 as compared to NOAA / METOP. Furthermore colder places (having temperature 240K and below) show more deviations in temperatures.

❖ The brightness temperatures of MIR channels of INSAT 3D and NOAA /METOP satellites in the month of FEB2015 gives an average **BIAS of 1.9K**. Furthermore warmer places (having temperature 295K and above) show more deviations in temperatures as compared to colder places.



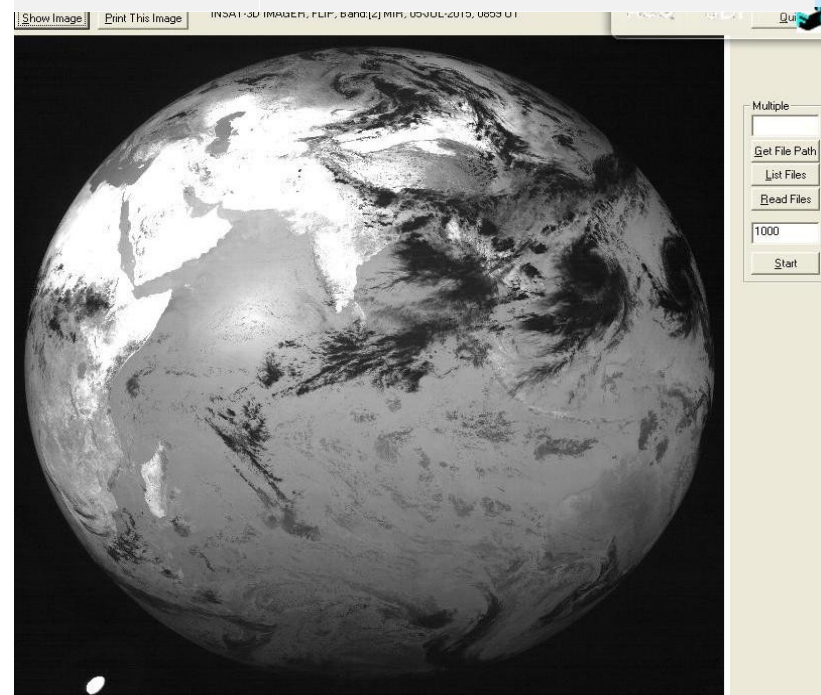
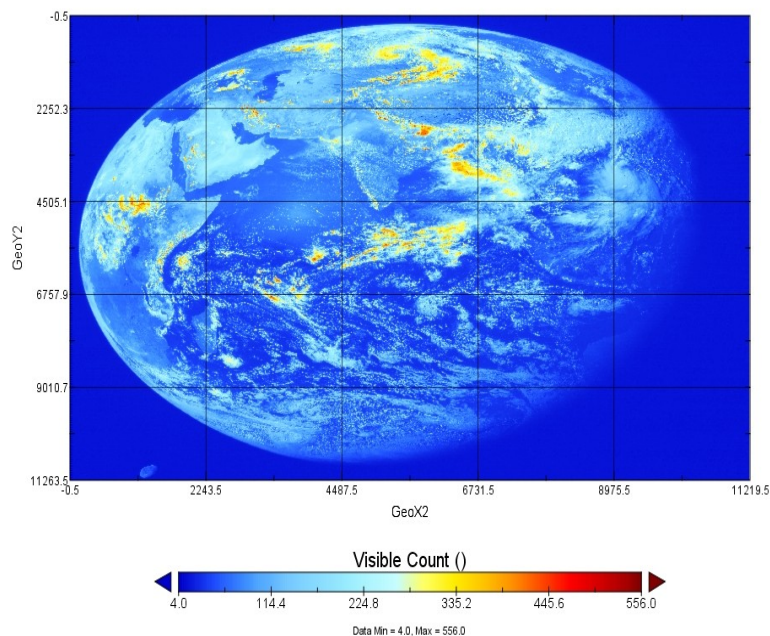
# **INSAT-3D Calibration using Moon data has been started at IMD**

- Lunar is resembling of moon. The purpose was to enable moon to be used as a radiance calibration source for earth-orbiting remote-sensing spacecraft.
- Using moon as reference of source for radiometric calibration and sensor stability.
- Procedure: Follow this document [https://gsics.nesdis.noaa.gov/pub/Development/LunarWorkArea/GSICS\\_ROLO\\_HighLevDescript\\_IODefinition.pdf](https://gsics.nesdis.noaa.gov/pub/Development/LunarWorkArea/GSICS_ROLO_HighLevDescript_IODefinition.pdf) from GSICS wiki.
- Downloaded GIRO\_v1.0.0 model from <https://gsics.nesdis.noaa.gov/wiki/Development/GiroUtil>



Spectral Bands	(um)	Resolution(km)
Visible	0.55 -0.75 um	1
Short Wave Infra Red	1.55 -1.70m	1
Mid Wave Infra Red	3.70 -3.95	4
Water Vapour	6.50 -7.10	8
Thermal Infra Red –1	10.30 -11.30	4
Thermal Infra Red –2	11.30 -12.50	4

Visible Count



**INSAT-3D MIR on 05 July, 2015 0859 UTC**

INDIA METEOROLOGICAL DEPARTMENT



# Thank you



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भारत मौसम विज्ञान विभाग  
INDIA METEOROLOGICAL DEPARTMENT

