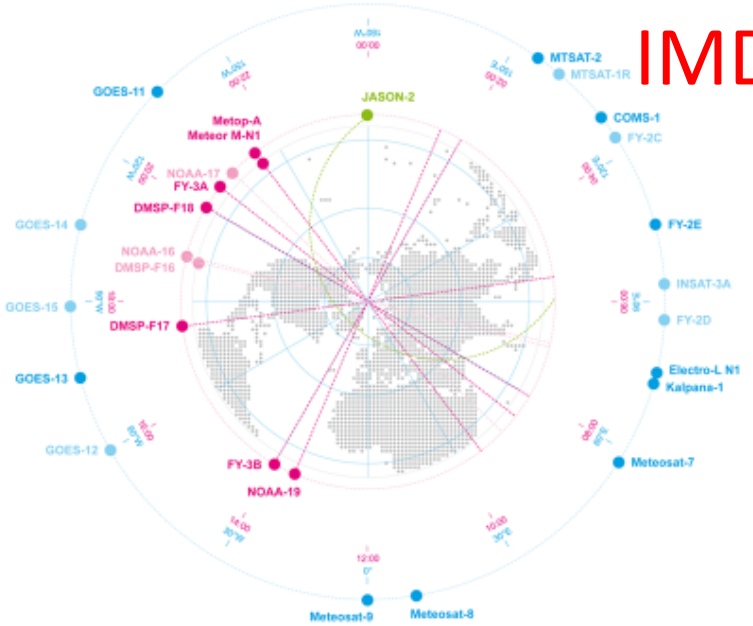


IMD Agency Report

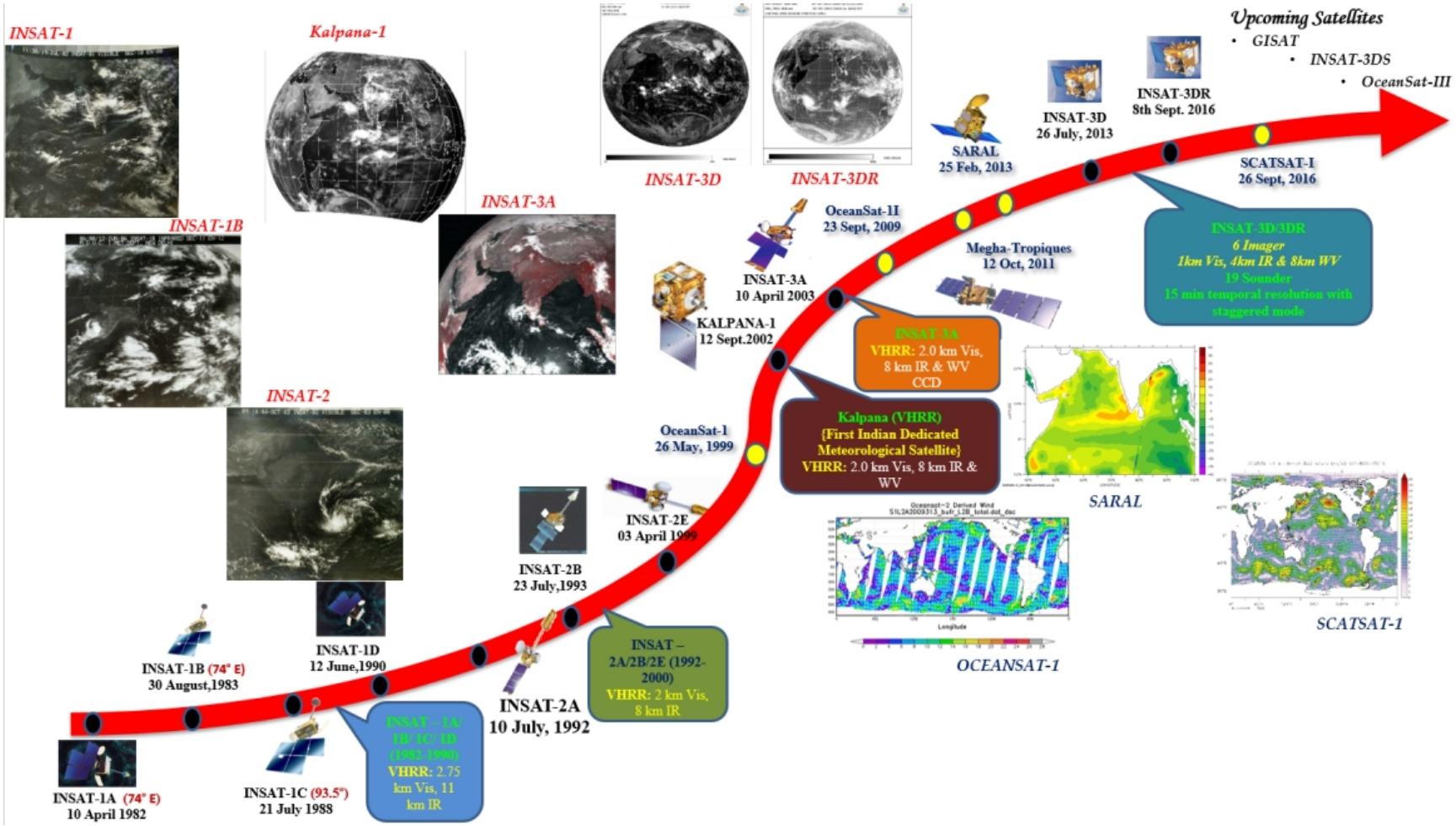
Status on the current and future satellite systems by IMD

Presented to CGMS-45, Plenary session, agenda item D.6

Coordination Group for Meteorological Satellites

CGMS

Overview - Planning of IMD satellite systems



Coordination Group for Meteorological Satellites

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Overview - Planning of IMD satellite systems

Satellite	Sensor	1980-1990	1990-2000	2000-2010	2010-2020
INSAT-1A (1982)	VHRR (VIS,TIR)	OLR, CMV, Rain, Cloud Image			
INSAT-1B (1983)	VHRR (VIS,TIR)	OLR, CMV, Rain, Cloud Image			
INSAT-1C (1988)	VHRR (VIS,TIR)	OLR, CMV, Rain, Cloud Image			
INSAT-1D (1990)	VHRR (VIS,TIR)		OLR, CMV, Rain, Cloud Image		
INSAT-2A (1992)	VHRR (VIS,TIR)		OLR, CMV, Rain, Cloud Image		
INSAT-2B (1993)	VHRR (VIS,TIR)		OLR, CMV, Rain, Cloud Image		
INSAT-2E (1999)	VHRR (VIS,WV,TIR) CCD (VIS,NIR,SWIR		OLR, AMV, UTH, Rain, Cloud Image		
Kalpana-1 (2002)	VHRR (VIS,WV,TIR)		OLR, AMV, UTH, Rain, Cloud Image		
INSAT-3A (2003)	VHRR (VIS,WV,TIR) CCD (VIS,NIR,SWIR		OLR, AMV, UTH, Rain, Cloud Image		
INSAT-3D (2013)	Imager (VIS, SWIR, MIR, WV, TIR1, TIR2) Sounder (18 IR + VIS)			OLR, AMV, UTH, Rain, Cloud Image Temperature, humidity profiles, Ozone	
INSAT-3DR (2016)	Similar to INSAT-3D			OLR, AMV, UTH, Rain, Cloud Image Temperature, humidity profiles, Ozone	
INSAT-3DS (2022)	Similar to INSAT-3D				OLR, AMV, UTH, Rain, Cloud Image Temperature, humidity profiles, Ozone

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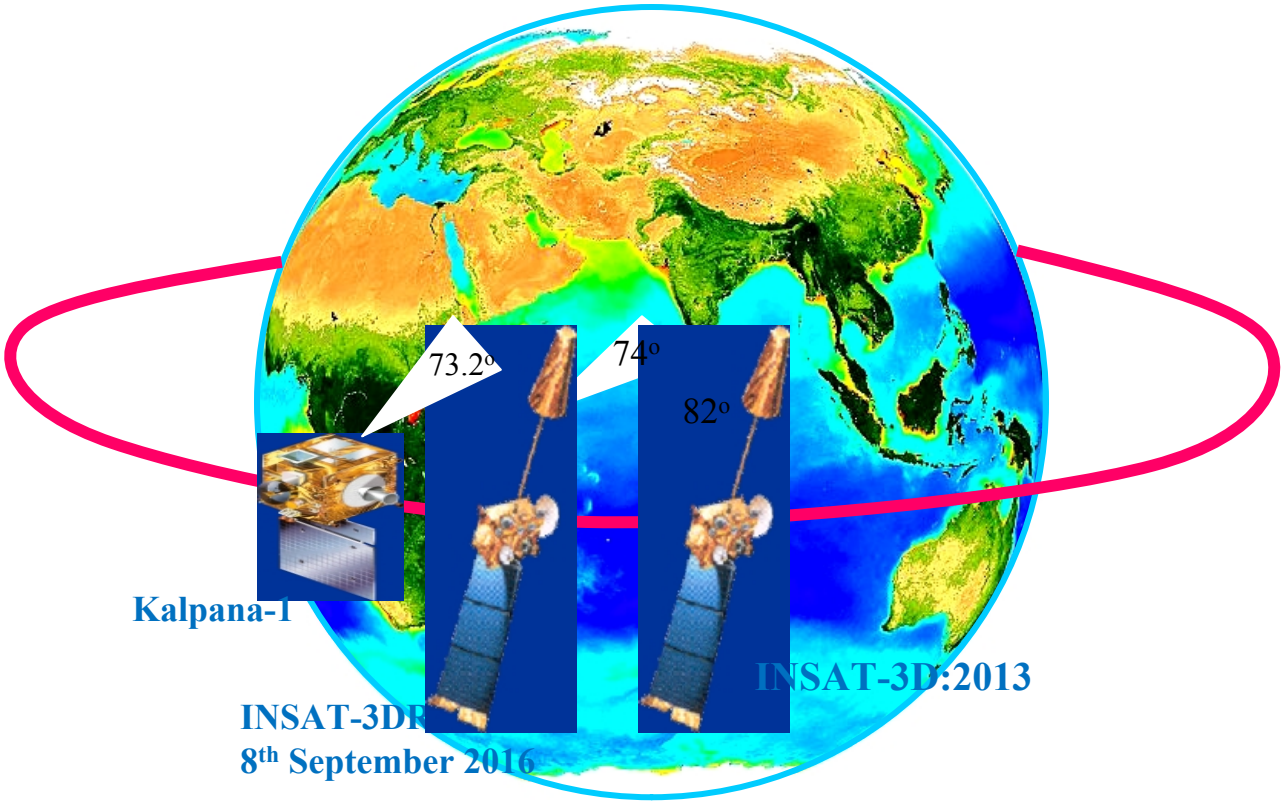
Current Indian Geostationary Meteorological Satellites



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INSAT-3DR

INSAT-3DR similar to INSAT-3D, is an advanced meteorological satellite of India configured with an imaging System and an Atmospheric Sounder was launched on 08th September 2016 from SDSC SHAR, Sriharikota using GSLV-F05 successfully and placed at 74 deg East. The significant improvements incorporated in INSAT-3DR are:

- Imaging in Middle Infrared band to provide night time pictures of low clouds and fog
- Imaging in two Thermal Infrared bands for estimation of Sea Surface Temperature (SST) with better accuracy
- Higher Spatial Resolution in the Visible and Thermal Infrared bands

And, like its predecessor INSAT-3D, INSAT-3DR carries a Data Relay Transponder as well as a Search and Rescue Transponder. Thus, INSAT-3DR will provide service continuity to earlier meteorological missions of ISRO and further augment the capability to provide various meteorological as well as search and rescue services.

Payloads of INSAT-3DR:

INSAT-3DR carries a multi spectral Imager, 19 channel Sounder, Data Relay Transponder and Search and Rescue Transponder.

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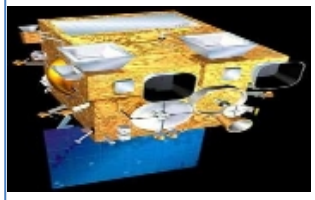
Current Indian Geo stationary Meteorological satellites

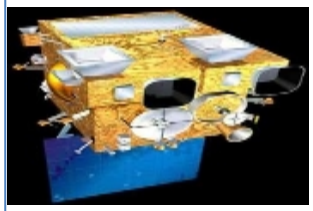
At present the following three INSAT satellites are in operation

Kalpana –1 is a metrological satellite which was launched in September 2002. It is located at 74^0 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-3D is a 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)



INSAT-3DR is a India's advanced dedicated meteorological satellite and was launched on 8th September, 2016 which carries four payloads: Imager (Six Channels),Sounder (Nineteen Channels),Data Relay Transponder(DRT) &Satellite Aided Search and Rescue (SAS & R).



INSAT-3DR will be used in staggered mode with INSAT-3D in order to reduce temporal resolution to 15 minutes.

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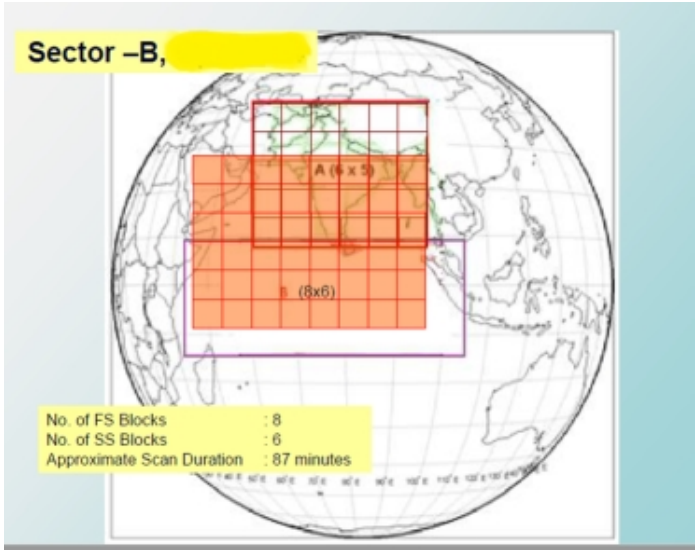
Present Operational Status

The present IMDPS system is used for processing and dissemination of data from all the three currently operational Geostationary satellites(Kalpana-1, INSAT-3D, INSAT-3DR).

INSAT Series	Temporal Resolution
K1-VHRR	Half Hourly(0015 & 0045 UTC)
3D -Imager (6 Channel)	½ hourly (0000 & 0030 UTC)
3D -Sounder (19 Channel)	1 ½ hourly (two times region-B) and hourly (Three times Region-A)
3DR -Imager (6 Channel)	½ hourly (0015 & 0045 UTC)
3DR -Sounder (19 Channel)	Hourly (Three times Region-A) and 1 ½ hourly (two times region-B)

Sounder Scan Strategy



Sector-A
0000UTC-INSAT-3D
0100UTC-INSAT-3D
0200UTC-INSAT-3D
0300UTC-INSAT-3DR
0400UTC-INSAT-3DR
0500UTC-INSAT-3DR

Sector-B
0000UTC-INSAT-3DR
0130UTC-INSAT-3DR
0300UTC-INSAT-3D
0430UTC-INSAT-3D

Then this cycle will be repeated on six hourly basis.

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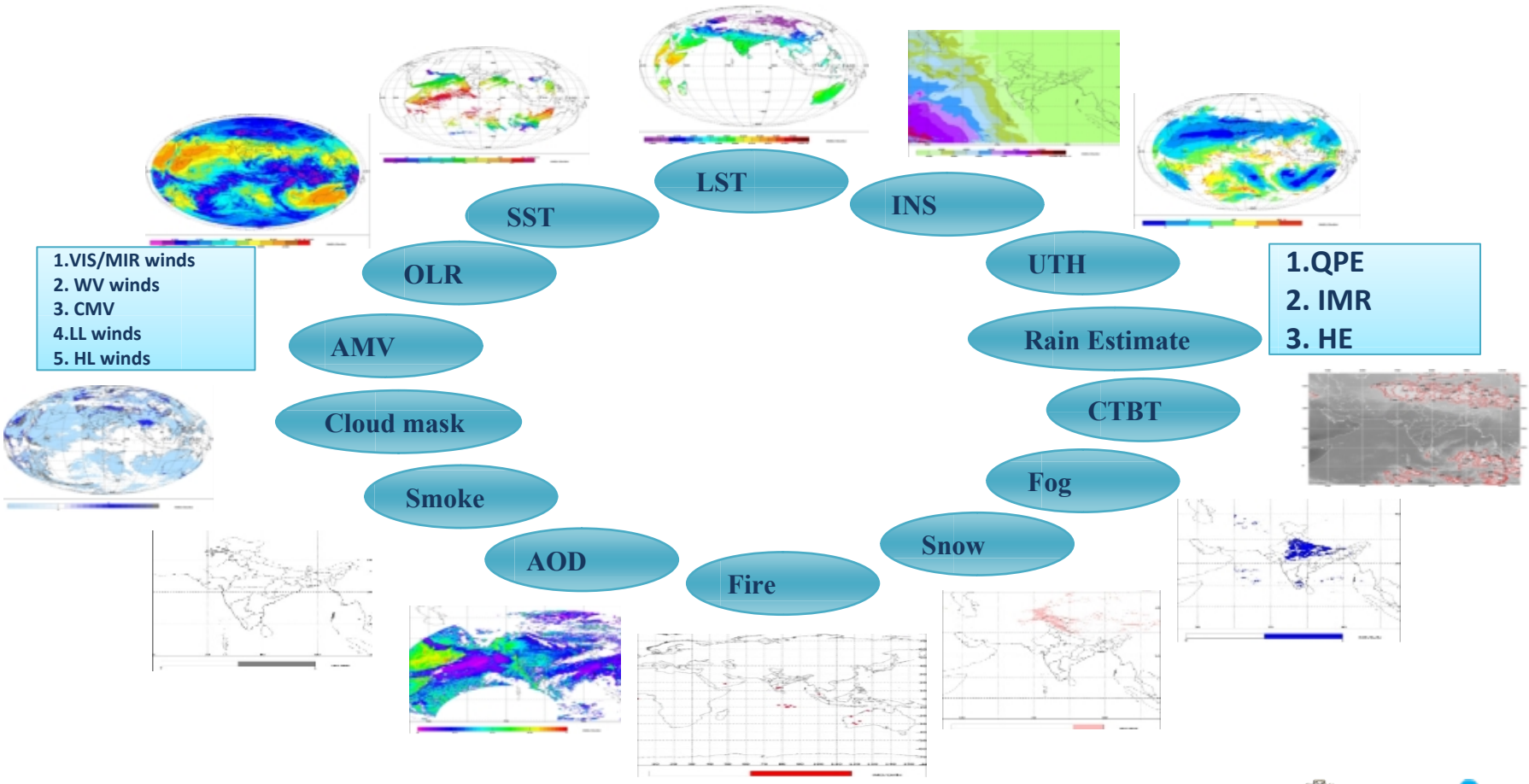
Geophysical parameters/products of INSAT-3D/3DR Imager



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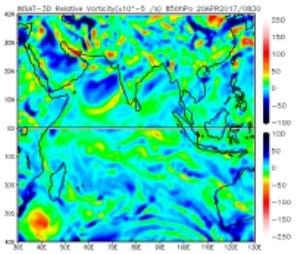
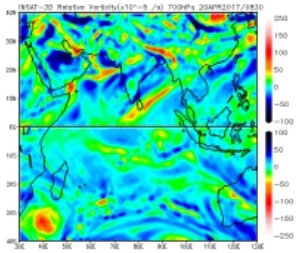
Wind Derived Products from INSAT-3D/3DR Imager Winds

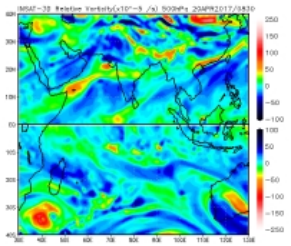
Vorticity



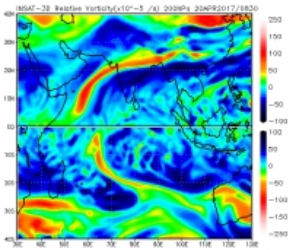
850 hPa



700 hPa

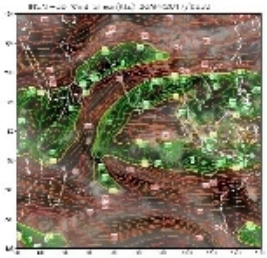


500 hPa

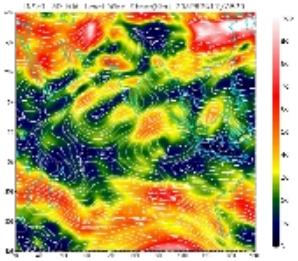


200 hPa

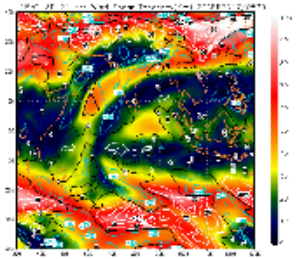
Wind Shear



Wind Shear

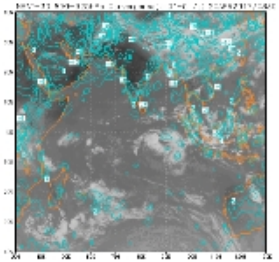


Mid Level Wind Shear

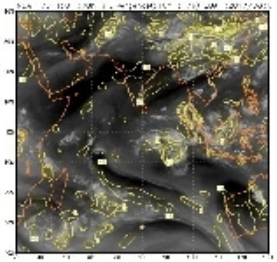


Wind Shear Tendency

Convergence & Divergence



Low Level Convergence

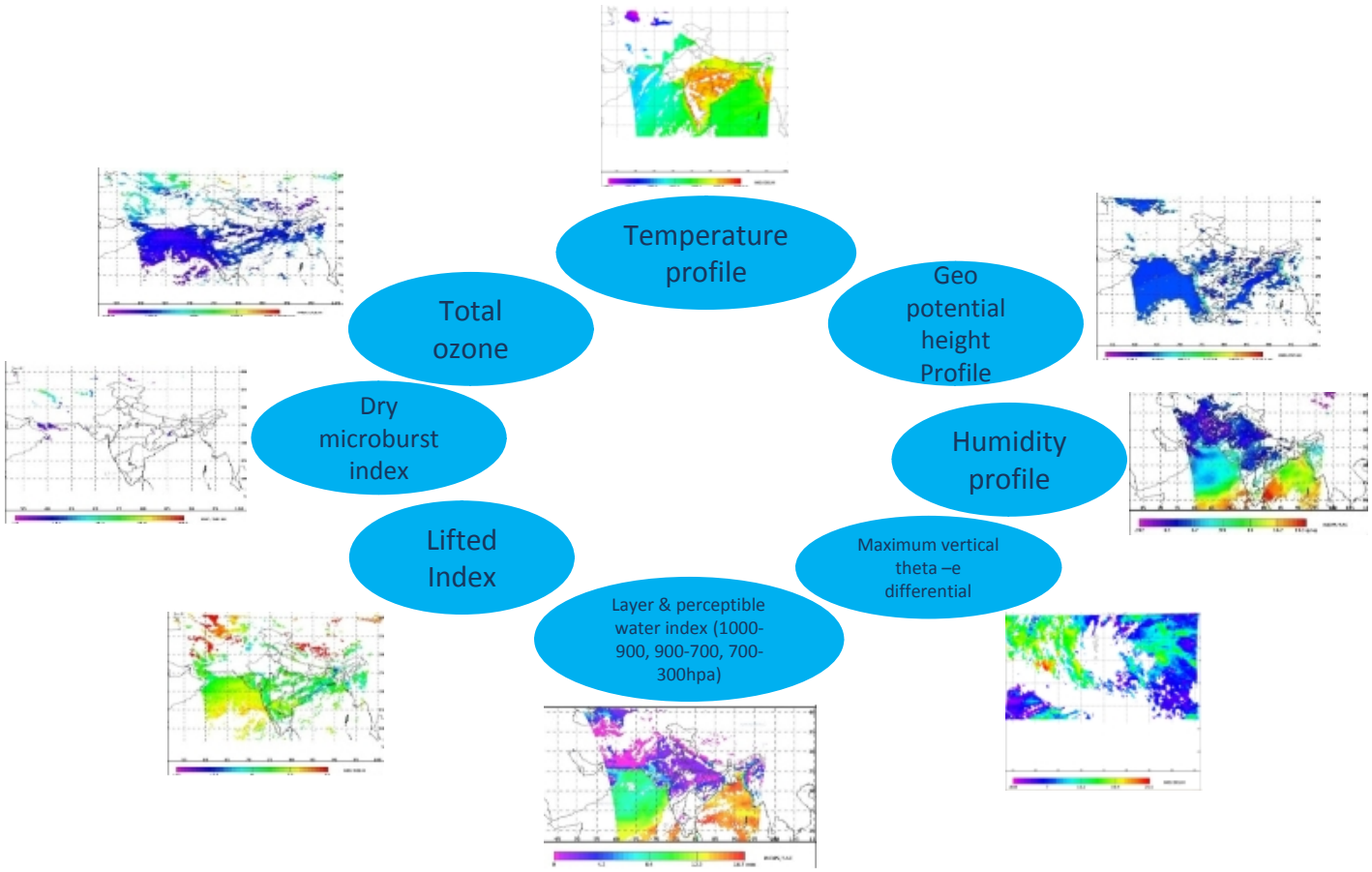


Upper level Divergence

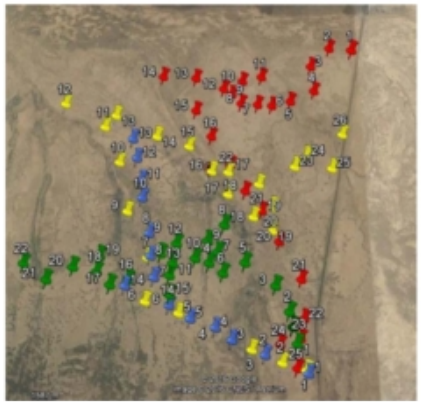
Detail of Images Generated from INSAT-3D/3DR Imager

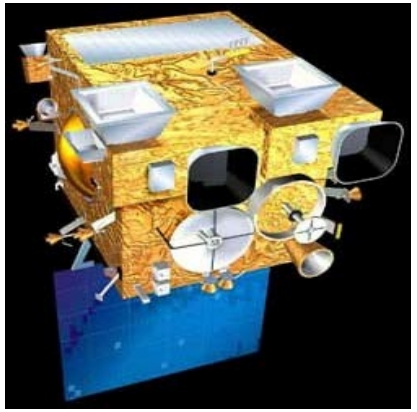
Sector Name	Channels	No. of Images
Full-Disk	IR1, IR1_Temp, IR2, IR2_Temp, MIR, MIR_Temp, VIS, SWIR, WV, WV_temp, MP	11
Asia-Sector	IR1, IR1_Temp, IR2, IR2_Temp, MIR, MIR_Temp, VIS, SWIR, WV, WV_temp, MP, CTBT	12
NEQUAD-Sector	IR1, IR1_Temp, IR2, IR2_Temp, MIR, MIR_Temp, VIS, SWIR, WV, WV_temp, MP	11
NWQUAD-Sector	IR1, IR1_Temp, IR2, IR2_Temp, MIR, MIR_Temp, VIS, SWIR, WV, WV_temp, MP	11
SGP-Sector	IR1, IR1_Temp, IR2, IR2_Temp, MIR, MIR_Temp, VIS, SWIR, WV, WV_temp, MP	11
NEQ (HR-Sector)	IR1_HR, IR1_HRBlue,IR1_Temp_BD, IR1_Temp_NHC, IR2_HR, IR2_HRBlue,VIS_HR, VIS_HRBlue, WV_HR, WV_HRBlue, MIR_HR, MIR_HRBlue, SWIR_HR, SWIR_HRBlue	14
NWQ (HR-Sector)	IR1_HR, IR1_HRBlue,IR1_Temp_BD, IR1_Temp_NHC, IR2_HR, IR2_HRBlue,VIS_HR, VIS_HRBlue, WV_HR, WV_HRBlue, MIR_HR, MIR_HRBlue, SWIR_HR, SWIR_HRBlue	14
Bay of Bengal (HR-Sector)	IR1_HR, IR1_HRBlue,IR1_Temp_BD, IR1_Temp_NHC, IR2_HR, IR2_HRBlue,VIS_HR, VIS_HRBlue, WV_HR, WV_HRBlue, MIR_HR, MIR_HRBlue, SWIR_HR, SWIR_HRBlue	14
Arabian Sea (HR-Sector)	IR1_HR, IR1_HRBlue,IR1_Temp_BD, IR1_Temp_NHC, IR2_HR, IR2_HRBlue,VIS_HR, VIS_HRBlue, WV_HR, WV_HRBlue, MIR_HR, MIR_HRBlue, SWIR_HR, SWIR_HRBlue	14
Amarnath Yatra (HR-Sector)	IR1_HR, IR1_HRBlue,IR1_Temp_HR, IR2_HR, VIS_HR, VIS_HRBlue, WV_HR, SWIR_HR, SWIR_HRBlue, MIR_HR, MIR_Temp_HR,	11
Vaishno Devi (HR-Sector)	IR1_HR, IR1_HRBlue,IR1_Temp_BD, IR1_Temp_NHC, IR2_HR, IR2_HRBlue,VIS_HR, VIS_HRBlue, WV_HR, WV_HRBlue, MIR_HR, MIR_HRBlue, SWIR_HR, SWIR_HRBlue	14
Nepal (HR-Sector)	IR1_HR, IR1_HRBlue,IR1_Temp_HR, IR2_HR, VIS_HR, VIS_HRBlue, WV_HR, SWIR_HR, SWIR_HRBlue, MIR_HR, MIR_Temp_HR, DMP	12
Fog (HR-Sector)	IR1_HR, IR1_HRBlue,IR1_Temp_HR, IR2_HR, VIS_HR, VIS_HRBlue, WV_HR, SWIR_HR, SWIR_HRBlue, MIR_HR, MIR_Temp_HR, DMP, NMP	13
	Total No of Images generated half hourly	162

Geophysical parameters OF INSAT-3D/3DR Sounder



Calibration Activities of IMD





GSICS Global Space-based Inter-Calibration System

इसरो ISRO SAC

EUMETSAT MONITORING WEATHER AND CLIMATE FROM SPACE

Coordination Group for Meteorological Satellites

CGMS

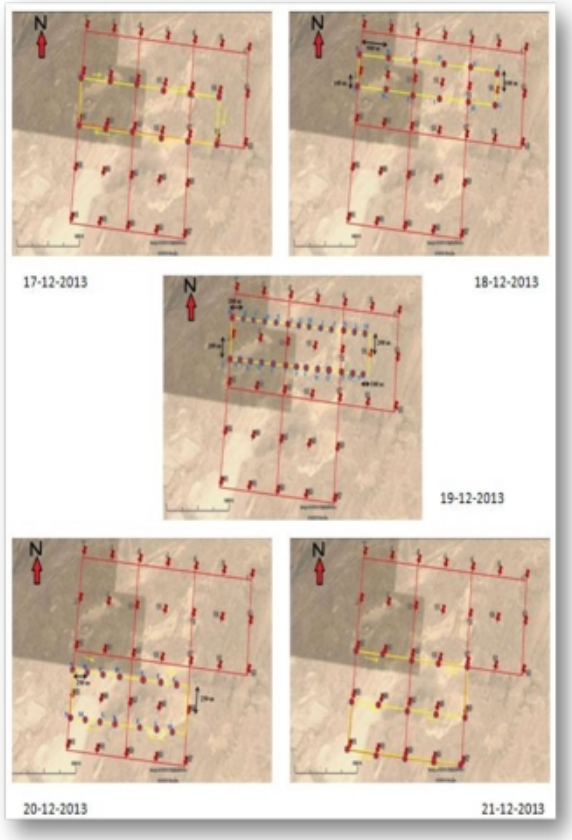
Calibration Activities at IMD

- Establishment of In-situ Calibration and Validation site for INSAT-3D/3DR satellite for Visible and SWIR sensor,

- Sustained and Coordinated Processing of Environmental Satellite data for Climate Monitoring (SCOPE-CM) for past Kalpana-1 and INSAT series of satellites

- Lunar/Moon Calibration of INSAT-3D/3DR

In-Situ calibration



The establishment of idle CAL/VAL site is very important because post-launch calibration and characterization of meteorological satellite sensors is a keenly felt need in most applications of satellite data for climate research which requires very high accuracies which can only be assured if the calibration of the instruments on board different satellites is accurately known and maintained.

Since the visible sensor on INSAT-3D has no onboard calibration device, it is necessary to develop post-launch calibration coefficients (or slopes) which take into account the in -orbit degradation of the sensor so that the derived products are rendered accurate.

A CAL/VAL site is therefore needs to be established and maintained.

Work done (Since 2013) for the Site suitability for vicarious calibration of imager. 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 and INSAT-3D satellite radiance matches as per expected.

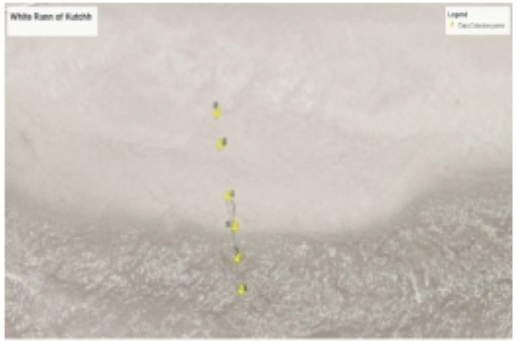


Figure 2: White Rann of Kutch along with data collection points for 01st May 2015.

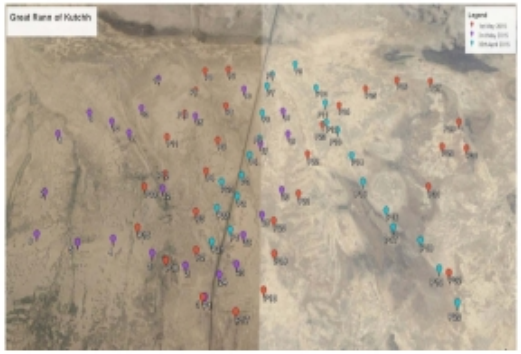
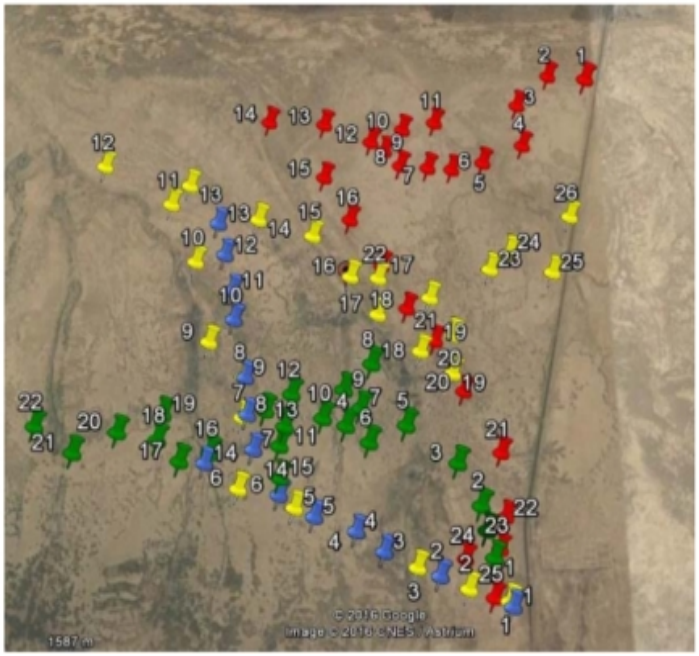


Figure 1: Calibration Site at Great Rann of Kutch including the data collection points.

INSAT-3D Cal/Val Site

Name of Site = Khawda (40km away from Bhuj), Great Rann of Kutchh, Gujarat



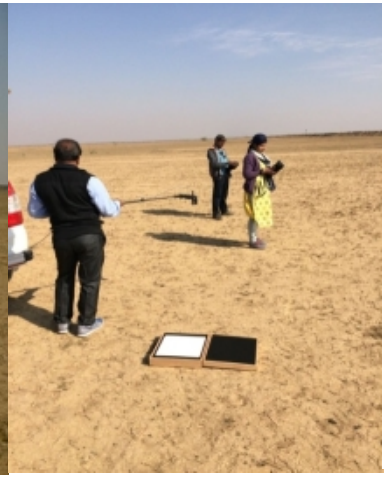
The Committee on Earth Observation Satellites (CEOS) Working group on Calibration and Validation identified several sites around the world based on the selection criteria, such as low probability of atmospheric interruptions, high spatial homogeneity, weak directional effects, flat reflectivity spectrum etc. Calibration sites are never chosen randomly, and to be adequate they must satisfy a certain number of criteria.

Based on the above criteria, we have selected a desert site in Great Rann of Kutchh (GROK), India. GROK site characterized as high and uniform reflectance land, was chosen to carry out vicarious calibration. The experimental site is placed about 40km away from Bhuj between Khawda and Loriya in Great Rann of Kutchh. The site is accessible near to road on the way to Khawda.

Initially, a joint campaign (Cal/Val team) with SAC/ISRO team were carried out from in 2013 to find a suitable site after visiting several locations in this region for the purpose to get information of uniformity, accessibility, useable area and local information of the site.

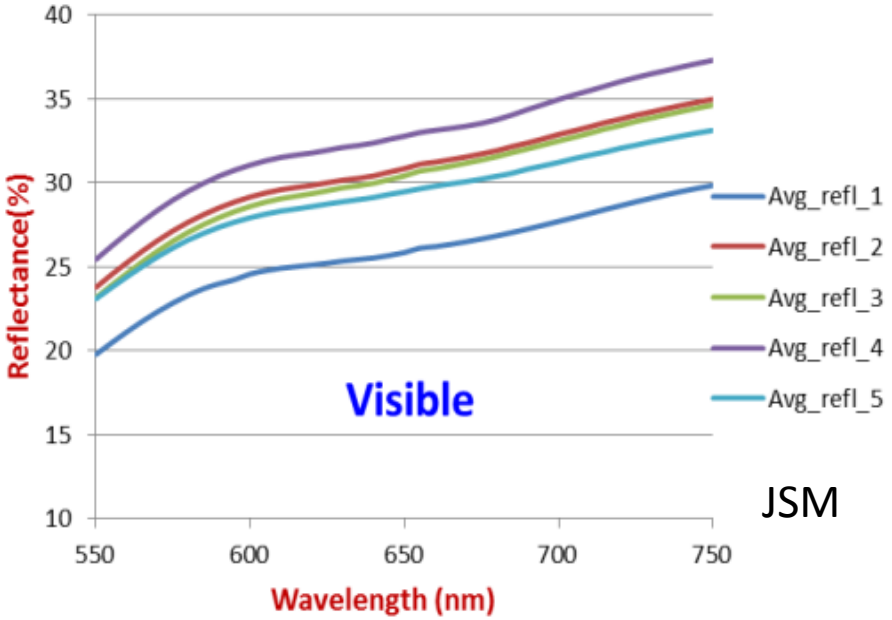
Again, joint campaign collaboration with SAC team during in 2014,2015 and 2016.This study details measurements carried out for the purpose of vicarious calibration of visible (VIS) and shortwave infrared (SWIR) channels of INSAT-3D imager over Bhuj in Great Rann of Kutchh.

Recent joint campaign of SAC/ISRO and IMD team were carried out from February 6th to February 10, 2017

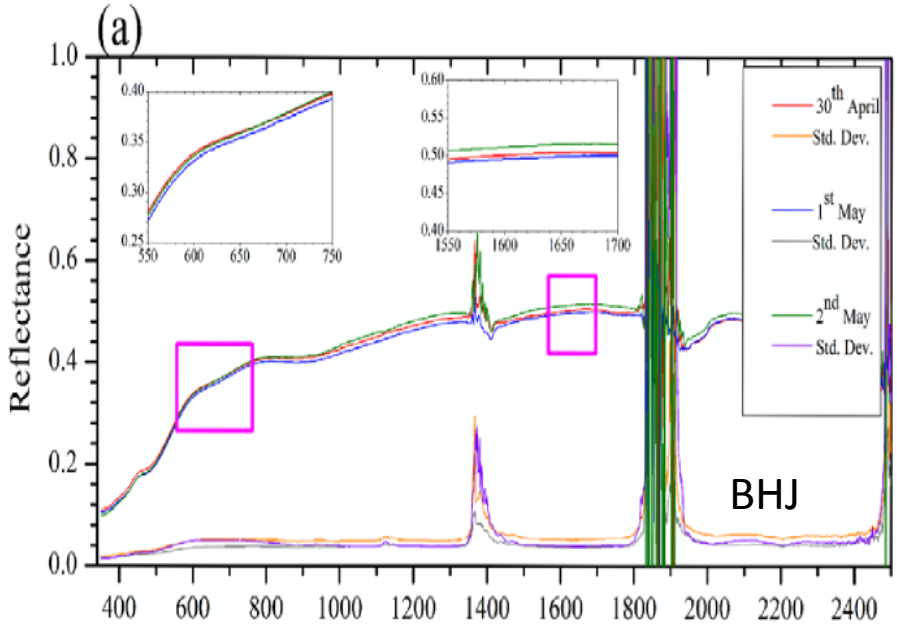


Cal-Val Team members from SAC-ISRO and IMD (Delhi and Bhuj) during calibration campaign (19th April, 2016 - 23rd April, 2016) at Bhuj, Great Rann of Kutch.

Spatial Variability of the Sites



JSM



BHJ

Courtesy:
Joint report IMD and SAC,(ISRO)

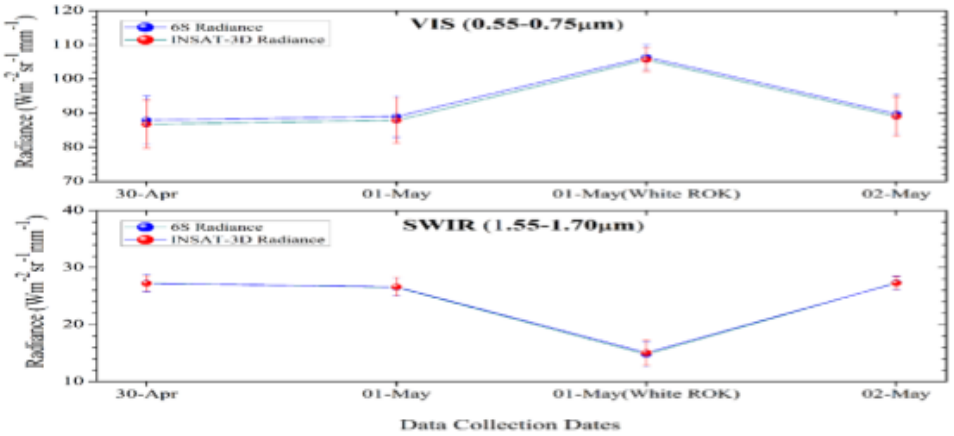


Figure 11: Daily variation of radiance from INSAT-3D and 6S simulated for VIS and SWIR channels.

Status of cal/val

The TOA radiance was simulated by 6S RT model using ground measurements. The conclusions based on this study are summarized below

1. **GROK site is the preferred site for post launch calibration due to its accessibility, high degree of homogeneity, which helps to derive precise vicarious calibration coefficients.**

2. **The 6S simulated radiances are well comparable with the INSAT-3D imager measured radiance for all three dates over GROK and for WROK.**

3. **The estimated overall uncertainties in the calibration coefficients are found to be 3% in VIS and 4% in SWIR channels**

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

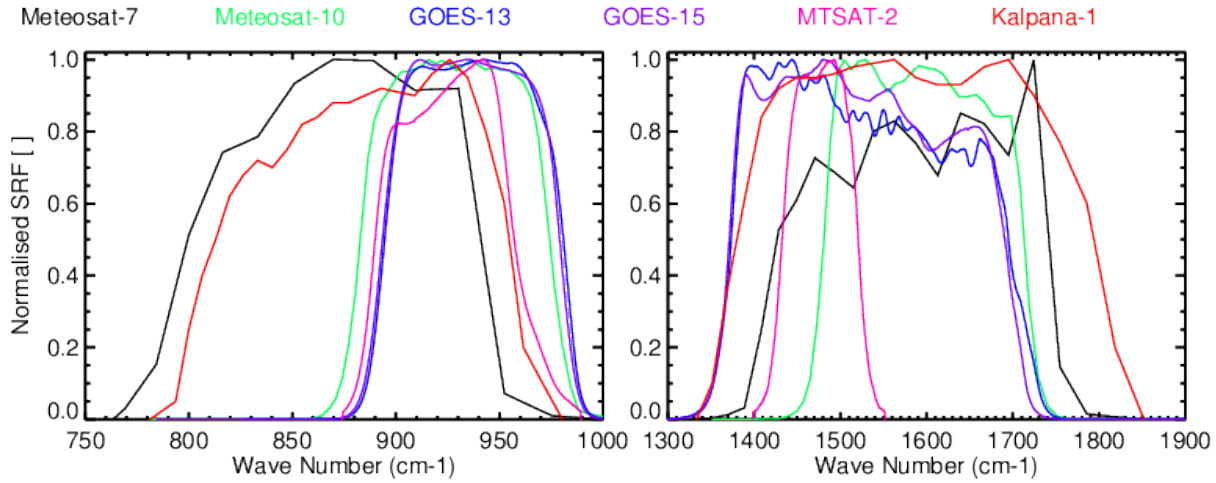
The India Meteorological Department (IMD) has been a part of the SCM-06 IOGEO project team.

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)* Ashim Kumar Mitra (IMD)

Recent work done for [GSICS/IOGEO] inter-comparison study

Workflow

- Participants develop test datasets which consists of sensor equivalent re-calibrated radiances* in each sensor's native resolution (intermediate files);
- Each participant could place their data on their FTP site at EUMETSAT;
- EUMETSAT takes the lead in performing the comparisons between the intermediate files and the references dataset. EUM then provides the Spectral Band Adjustment Factors (SBAFs) that are needed to convert the sensor equivalent re-calibrated radiances* to reference sensor normalised radiances** (inter-calibration corrections);
- EUM creates files of reference sensor normalised radiances of all sensors in a common grid which will be used for comparison.



Monitored Instr.: Meteosat-7 (EUMETSAT), Meteosat-10 (EUMETSAT), GOES-13 (NOAA), GOES-15 (NOAA), MTSAT-2 (JMA), FY-2 (CMA), and Kalpana (IMD)

Coordination Group for Meteorological Satellites

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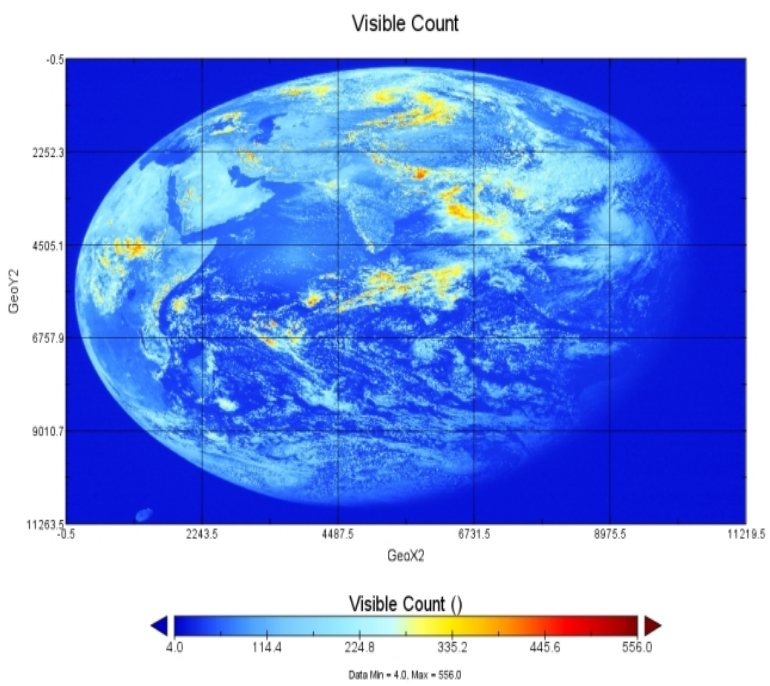
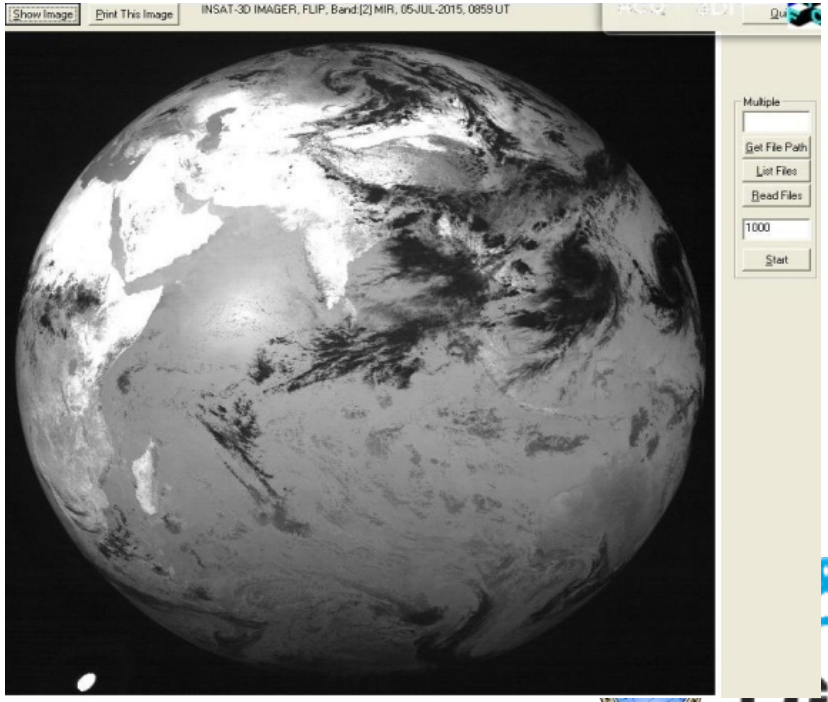
INSAT-3D Calibration using Moon data has been started at IMD

- 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.
- Follow this document 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

(Courtesy: Sebastian, Tim Hewison and Masaya)

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

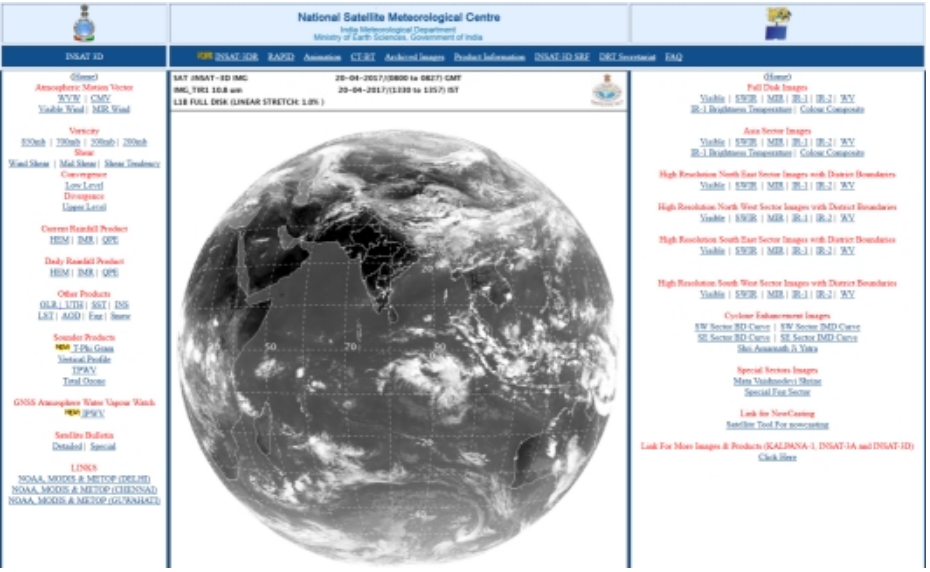


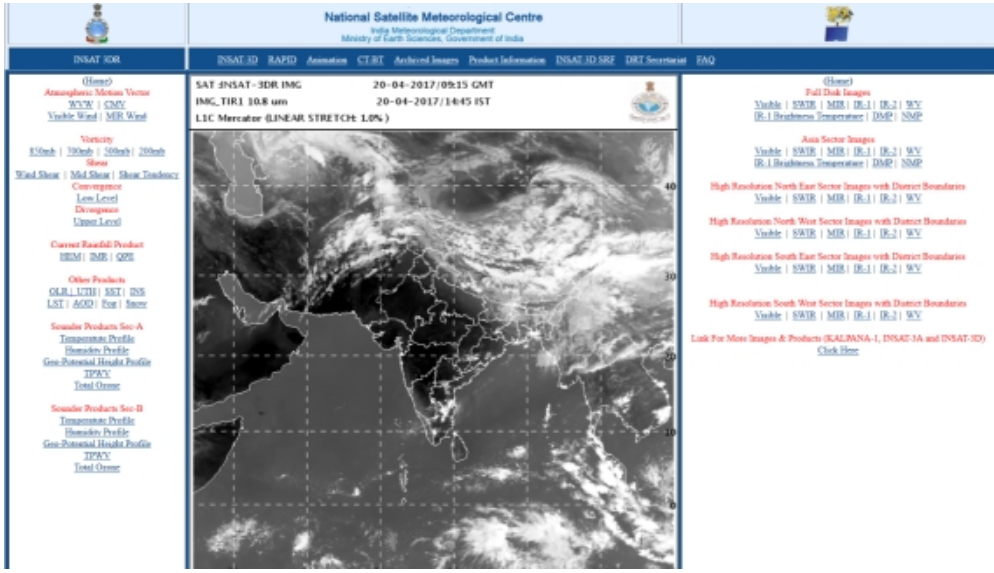


INSAT-3D MIR on 05 July,2015 0859 UTC

Dissemination through a dedicated IMD web site Updated every fifteen Minutes

http://satellite.imd.gov.in/insat.htm





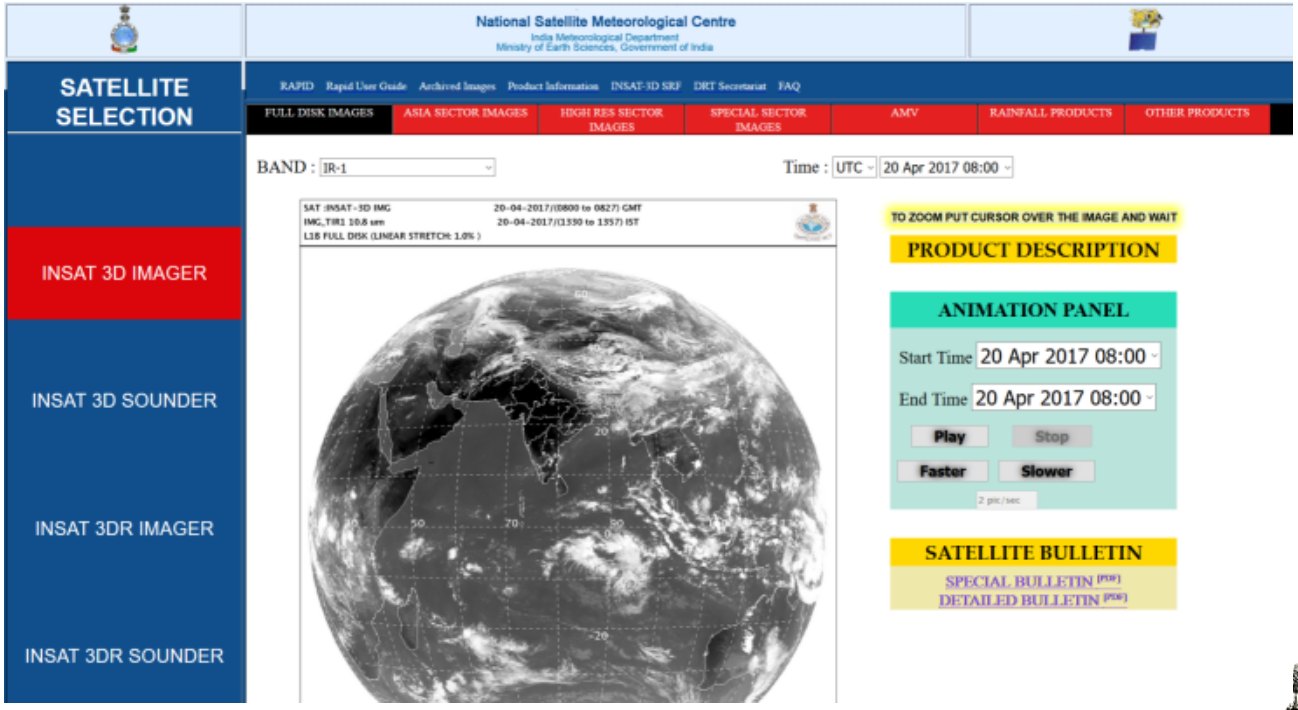
Coordination Group for Meteorological Satellites

CGMS

Dissemination through a dedicated IMD web site Updated every fifteen Minutes

http://satellite.imd.gov.in/joy_insat_final.htm

- Provision to view last 48 channel images/products images through drop down menu.
- Product description of all Imageries and Products are made available on webpage.
- Provision for running Animation for all channel images/products images for last 48 scans along with date and time selection.

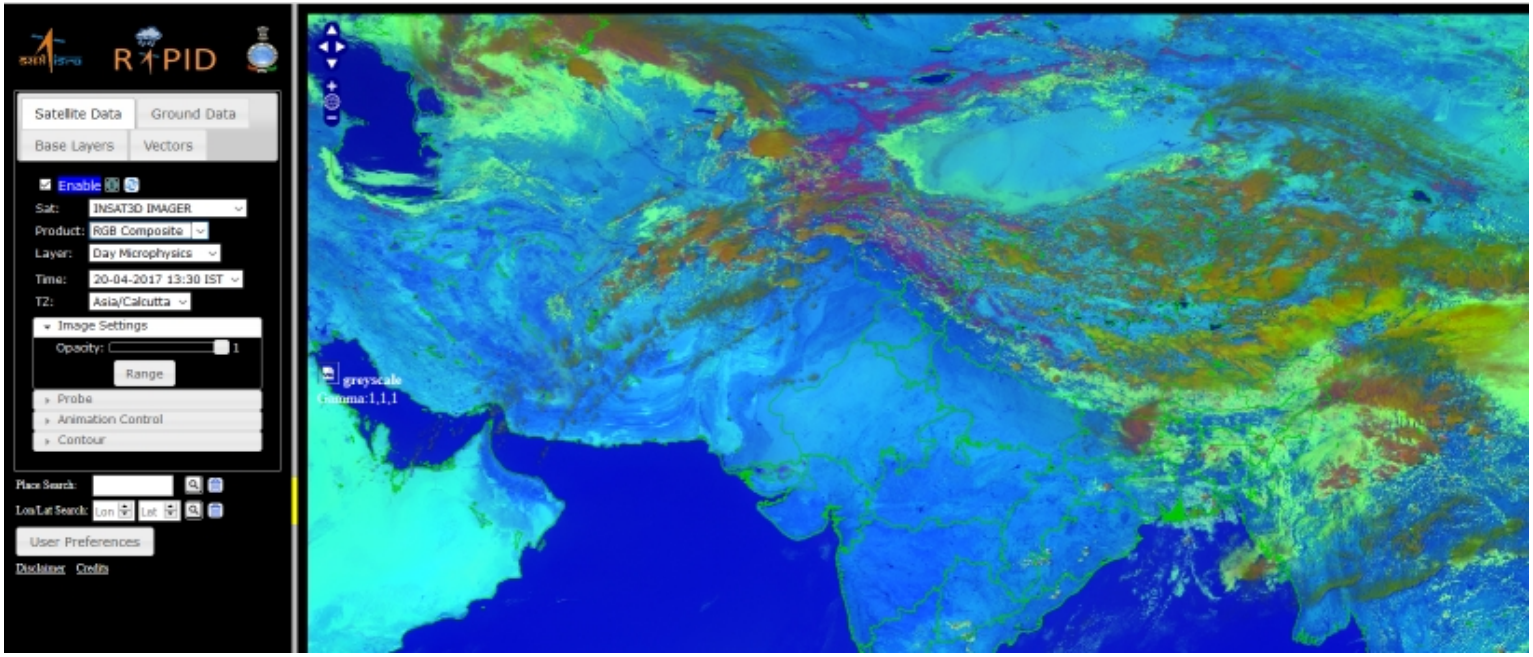


Online Archival of all channel images & products images are available of last six month

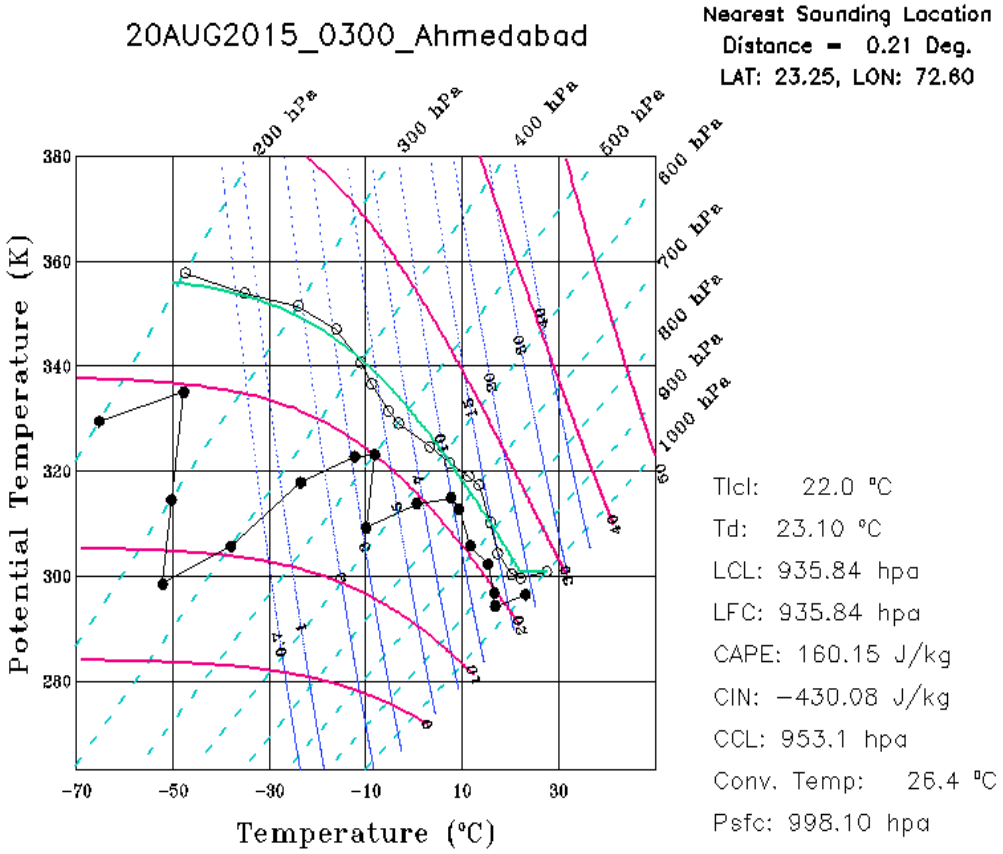
http://satellite.imd.gov.in/archive/

RAPID

RAPID (Real time Analysis of Products & Information Dissemination) :- It is a web based quick visualization and analysis tool for satellite data on a real time basis. This introduces Next Generation Weather Data Access & Advanced Visualization.
http://www.rapid.imd.gov.in



Provision of generation of T-phi gram for 105 locations.

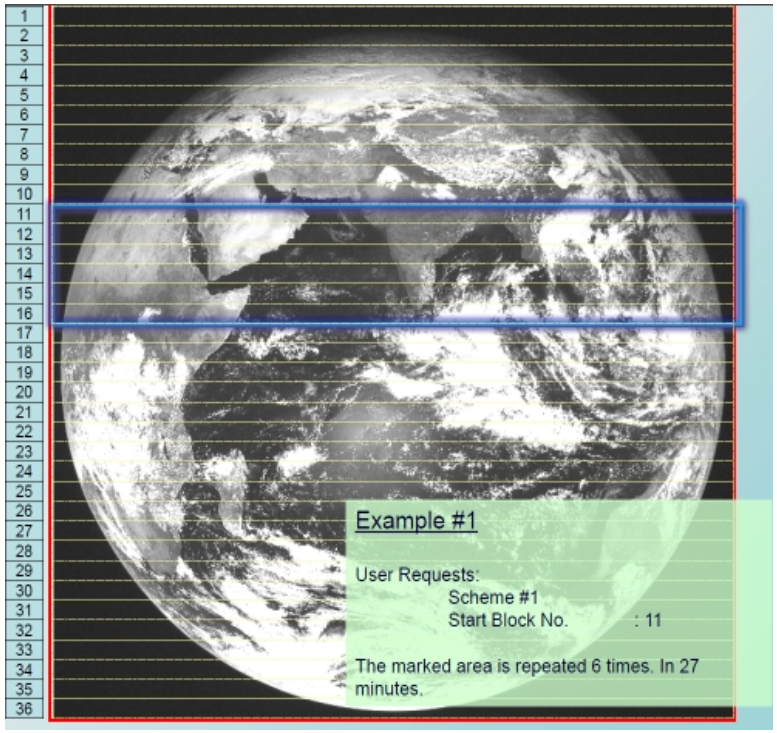


Coordination Group for Meteorological Satellites

CGMS

Rapid Scan Strategy of Imager of INSAT-3DR to be adopted during Cyclone/ specific weather event.

- Extent of coverage: 6 Blocks (3° coverage in 234 lines)
- No. of repetitions: 6
- Time required: 27 minutes
- (6 blocks with 6 repetitions)



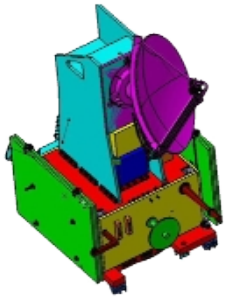
Super Rapid Scan Strategy of Imager of INSAT-3DR to be adopted during thunderstorm activities on need basis.

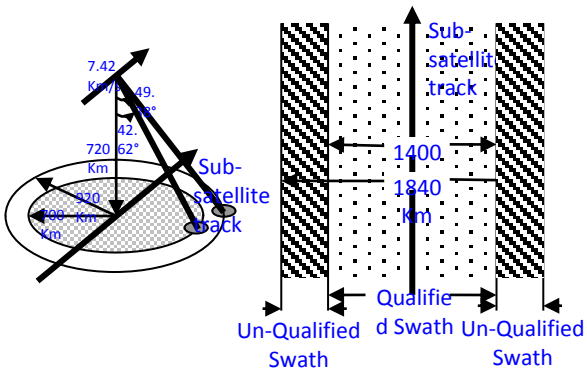
Extent of Coverage : 1 Blocks (0.50 N-S in 39 scan lines)
No. of repetitions : 6
Scan duration : 5 minutes

SCATSAT-1

SCATSAT-1 is a continuity mission for Oceansat-2 Scatterometer to provide wind vector data products for weather forecasting, cyclone detection and tracking services to the users. The satellite carries Ku-band Scatterometer similar to the one flown onboard Oceansat-2. The spacecraft is built around standard IMS-2 Bus and the mass of the spacecraft is 371 kg. The spacecraft has been put in SSP orbit of 720 km altitude with an inclination of 98.1 deg by PSLV-C35 on September 26, 2016 from the First Launch Pad of SDSC SHAR, Sriharikota. The mission life of the satellite is 5 years.

- 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: O 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.

SCATSAT-1Dataset Availability

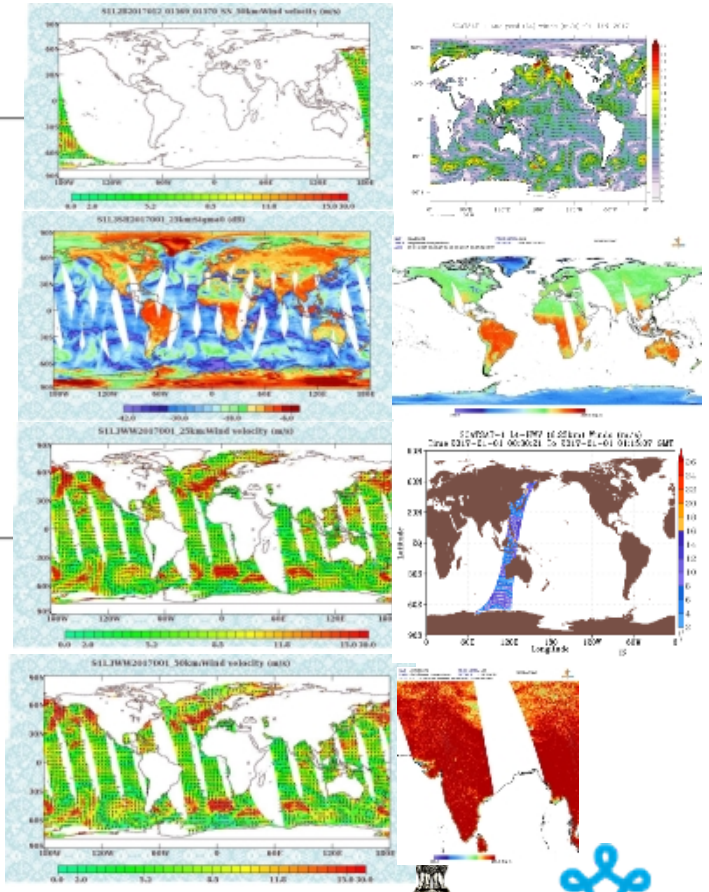
The SCATSAT-1 dataset is available on following link: ftp://ftp.mosdac.gov.in/

FTP directory /2017/JAN/ at ftp.mosdac.gov.in

Up to higher level directory

01/11/2017 03:15PM	Directory	L2B
01/11/2017 03:15PM	Directory	L3S
01/11/2017 03:16PM	Directory	L3W
01/11/2017 03:27PM	Directory	L4AW
01/11/2017 03:27PM	Directory	L4FULLGLOBE
01/11/2017 03:27PM	Directory	L4HW
01/11/2017 03:27PM	Directory	L4INDIA
01/11/2017 03:27PM	Directory	L4NPOLAR
01/11/2017 03:27PM	Directory	L4SPOLAR

S1L2B2017012_01569_01570_SN_50km.h5
S1L3SH2017001_25km.h5
S1L3WW2017001_25km.h5
S1L3WW2017001_50km.h5
S1L4AW_2017001.nc
S1L4BH_2017009_2017010_ASC_GL625.jpg
S1L4HW_2017001_01405_01406_NS.nc
S1L4BH_2016366_2017001_ASC_IN.jpg

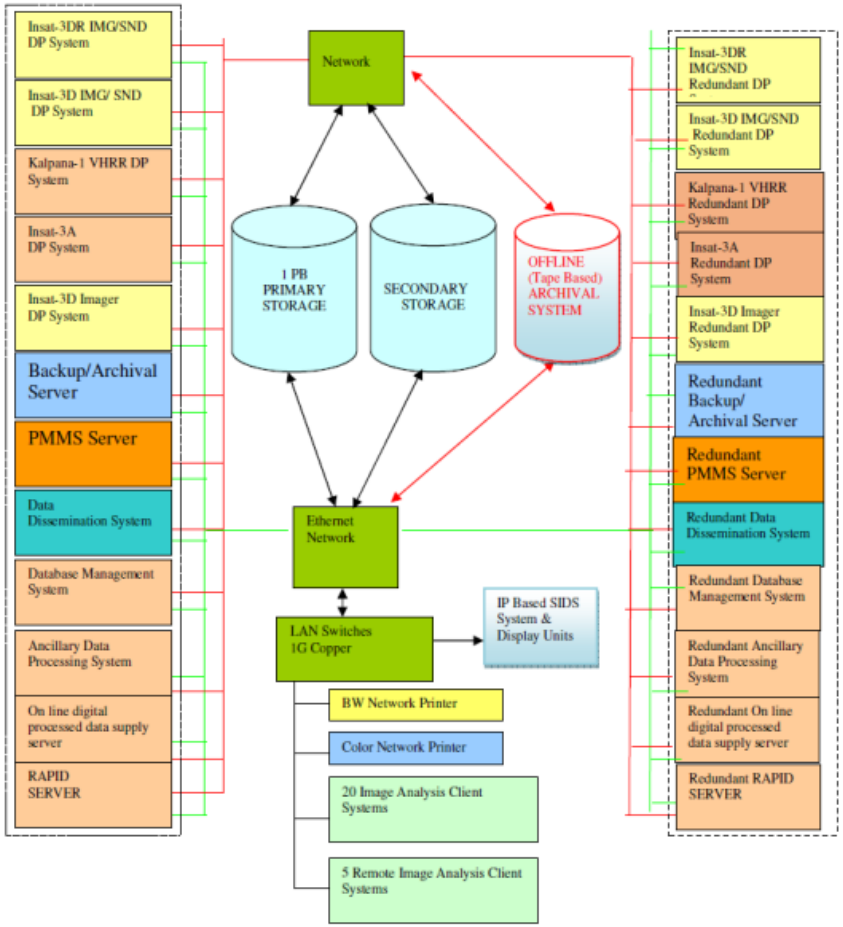


Coordination Group for Meteorological Satellites

CGMS

Multi-Mission Meteorological Data Receiving & Processing System (MMDRPS)

- IMD is in process to install **Multi-Mission Meteorological Data Receiving & Processing System (MMDRPS),** for reception, processing and dissemination of meteorological data of INSAT-3D/3DR/3DS and Kalpana-1.
- MMDRPS will have very high end processing system which will cut down the processing time from currently 15 minutes to 5 minutes.
- MMDRPS will have storage capacity of the order of 1PB which will facilitate online sharing of processed data for all Indian meteorological satellites to the registered users as per IMD data policy.



Coordination Group for Meteorological Satellites

CGMS

FUTURE GEO SATELLITES – INSAT-3DS

INSAT-3DS: India will launch this exclusive third meteorological satellite of this series in 2022.

Payloads	Channel	Resolution	Data Rate/Bandwidth
Imager	visible (0.52-0.77 µm)	1x1 Km	3.92725 Mbps
	SWIR (1.55-1.70 µm)	1x1 Km	
	MIR (3.8-4.0 µm)	4x4 Km	
	WV (6.5-7.1 µm)	8x8 Km	
	TIR-1 (10.3-11.3 µm)	4x4 Km	
	TIR-2 (11.5-12.5 µm)	4x4Km	
Sounder	LWIR -7 channel (14.71-12.02 µm)	10x10 Km	40.00 Kbps
	MWIR-5 Channel (11.03-6.51 µm)		
	SWIR-6 Channel (4.57-3.74 µm)		
	VIS (0.695 µm)		
DRT	Up link 402.75MHz		
S&SR	Up link 406.05MHz		

FUTURE GEO SATELLITES – GISAT-1

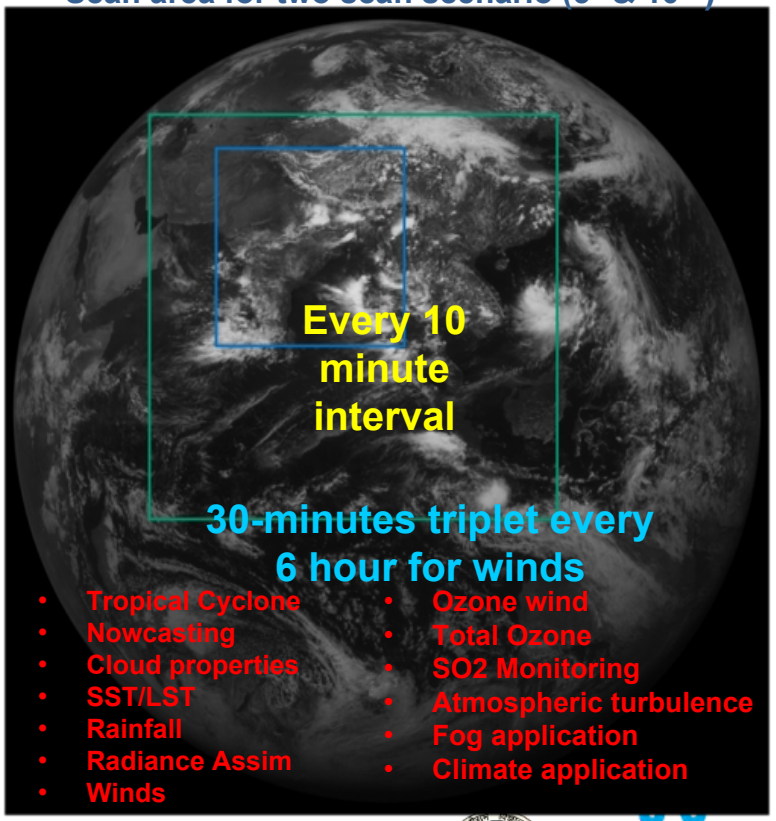
Launch Schedule: 2019, Geostationary orbit, 83E

MX-VNIR: Multispectral - Visible Near Infrared, HySI-VNIR: Hyperspectral Imager - Visible Near Infrared, HySI-SWIR: Hyperspectral Imager - Short Wave Infrared, MX-LWIR: Multispectral - Long Wave Infrared.

Band	Ch	SNR/N EdT	IFOV (m)	Range (μm)	Channels (μm)
MX-VNIR	4	> 200	50	0.45 - 0.875	B1: 0.45-0.52 B2: 0.52-0.59 B3: 0.62-0.68 B4: 0.77-0.86 B5N: 0.71-0.74 B6N: 0.845-0.875
HyS-VNIR	60	> 400	500	0.375 - 1.0	Δλ < 10 nm
HyS-SWIR	150	> 400	500	0.9 - 2.5	Δλ < 10 nm
MX-LWIR	6	NEdT < 0.15K	1500	7.0 – 13.5	CH1: 7.1-7.6 CH2: 8.3-8.7 CH3: 9.4-9.8 CH4: 10.3-11.3 CH5:11.5-12.5 CH6: 13.0-13.5

GISAT Scan scenario

Scan area for two scan scenario (5° & 10 °)

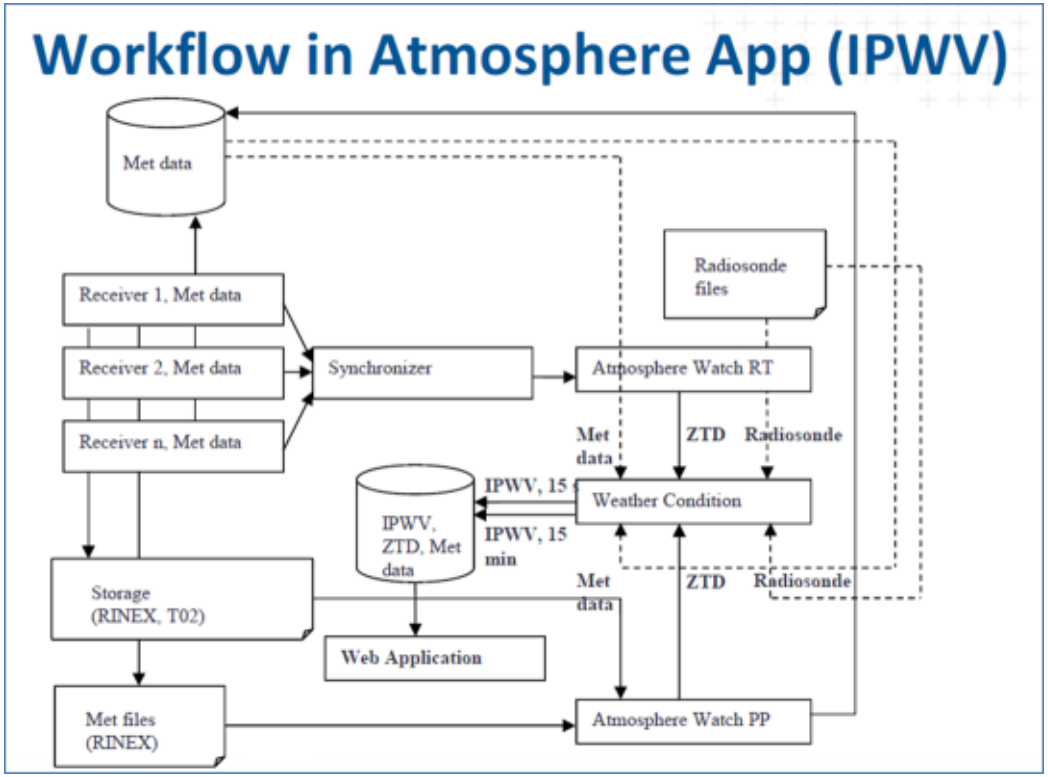


Coordination Group for Meteorological Satellites

CGMS

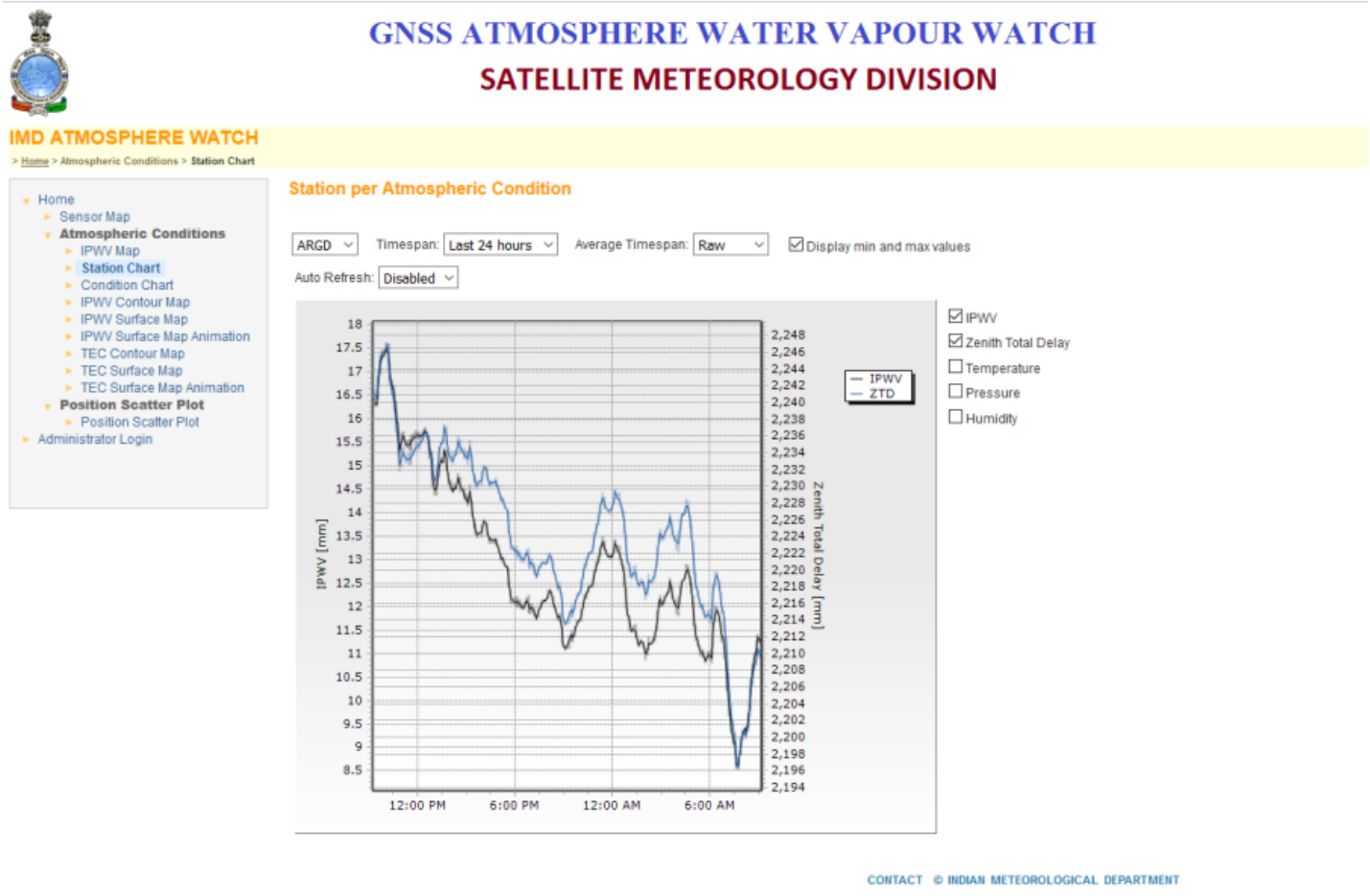
IMD - GNSS Network – Present Status

25 GNSS + 5 GPS



Dissemination through a dedicated IMD web site Updated every fifteen Minutes

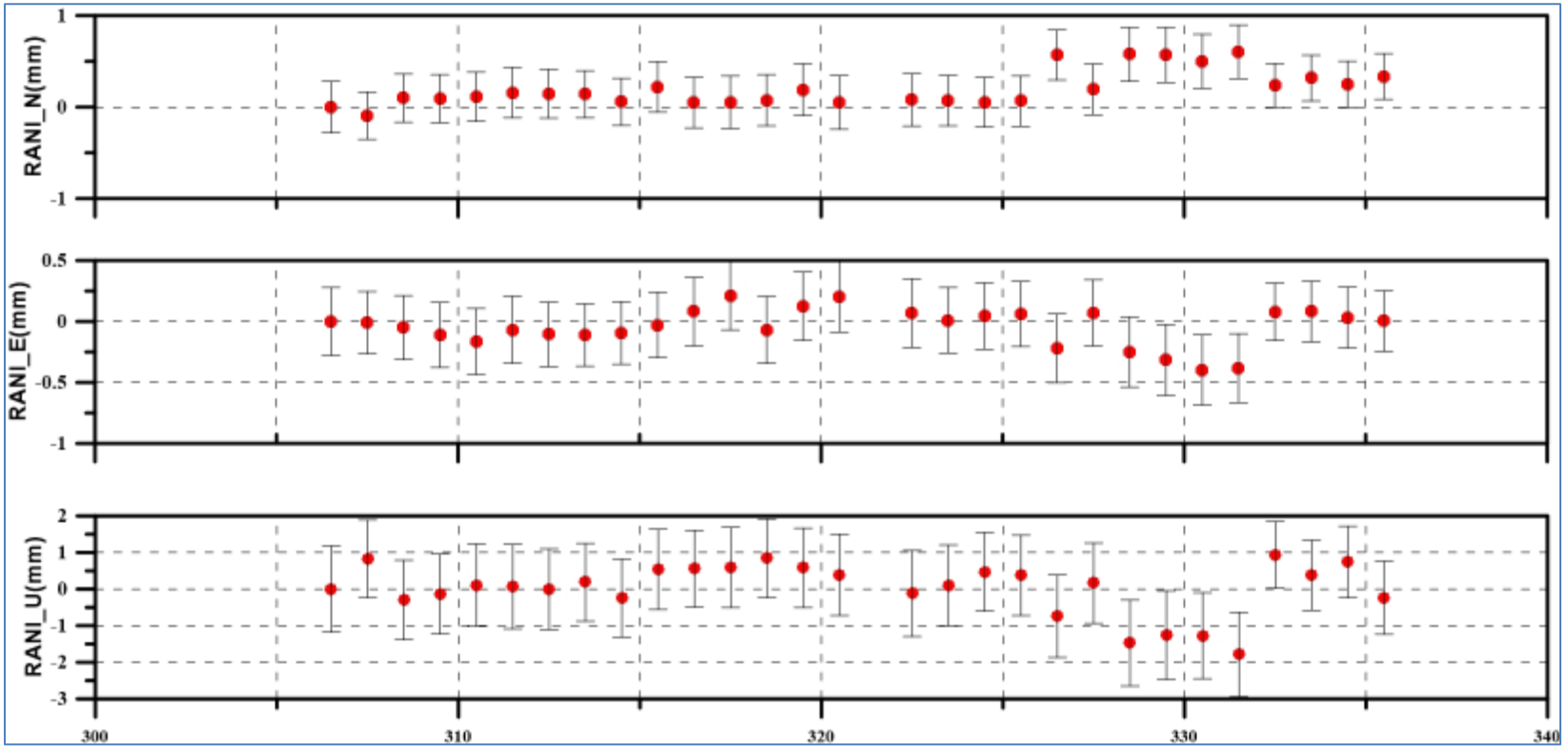
http://gnss.imd.gov.in/TrimblePivotWeb/



Coordination Group for Meteorological Satellites

CGMS

GNSS Network data are also being used for variation of XYZ Coordinate with respect to IGS Reference Stations for seismological use



Satellite Bulletins issued by IMD

Special Winter bulletin

FDP Satellite inputs 2nd Dec, 2016

Fog

North India

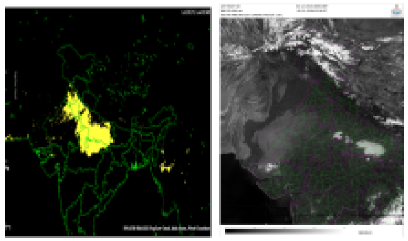
Onset: 18.30 UTC of 01.12.2016 at central UP

Maximum Extent: 0800 UTC spread over Punjab&N Rajasthan, Haryana, UP, north MP

Dissipate: Still persisting over SE UP (0800 UTC of 2.12.2016)

Area at maximum extent: 388000 sq.km Approx.

Major Rail Tracks Affected:Bhatinda-Patiala- Panipath-Delhi-Mathura-Gwalior-Kanpur-Lucknow-Gorakhpur-Allahabad-Rewa.

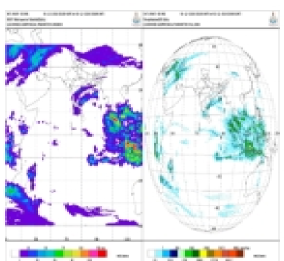


Fog Product in RAPID 0800 UTC 02.12.2016 Visible channel image 0800 UTC 02.12.2016

Daily Rainfall over north India

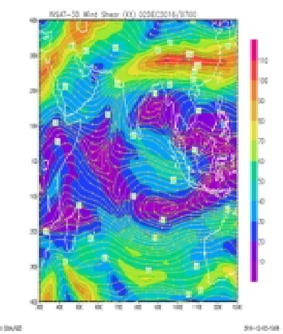
INSAT Multispectral rainfall Product: Upto 10mm recorded over east J&K adjoining HP

Hydro Estimator Product: No rainfall



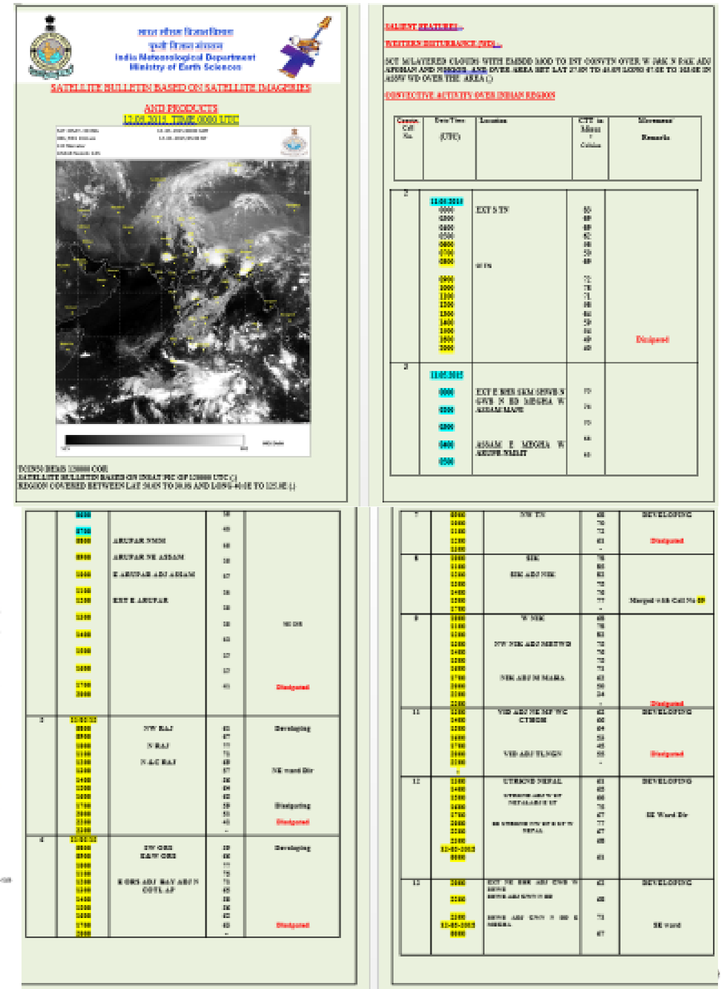
INSAT Multispectral Rainfall Daily Hydro Estimator Daily

Interpretation of derived products: (based on INSAT-3D products)



Wind shear overnorth India is ranging from 40-80kts.

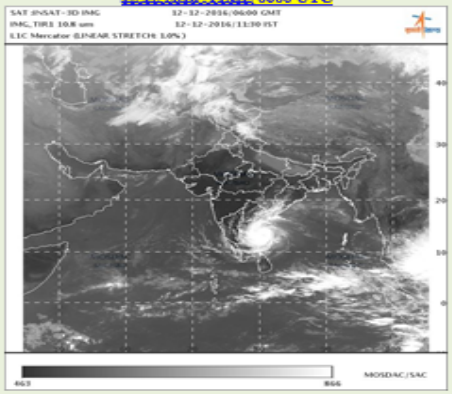
Thunderstorm Bulletin



Special Satellite Fix Bulletin for Cyclone

भारत मौसम विज्ञान विभाग
पृथ्वी विज्ञान मंत्रालय
India Meteorological Department
Ministry of Earth Sciences

SPL SATELLITE FIX BULLETIN BASED ON SATELLITE IMAGERIES AND PRODUCTS
12.12.2016 TIME 0600 UTC



TCIN50 DEMS 120600

A. TROPICAL DISTURBANCE (VARDAH)

B. 12/0600Z

C. 13.2N

D. 80.8E

E. INSAT 3D

F. T 4.0/4.0

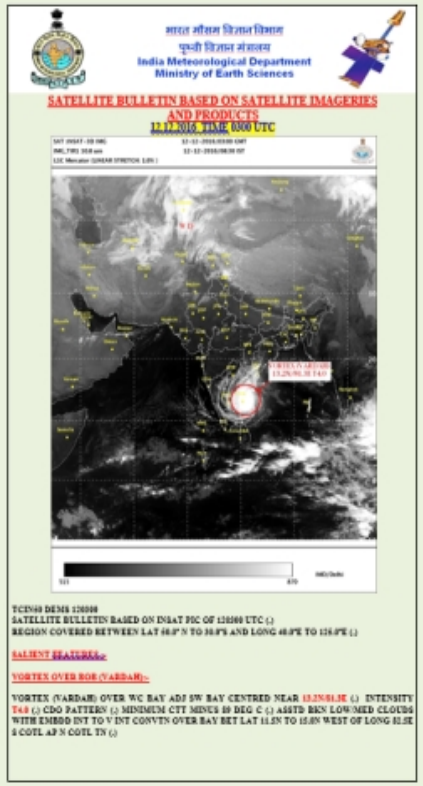
G. VIS / IR

H. REMARKS...EYE PATTERN WITH EMBEDDED DISTANCE GRATER THAN 0.75 DEGREE (E 5, EYE ADJUSTMENT FOR RAGGED EYE = 1.0 B. F. = 0.5) YEILDING DT = 4.5 P.T. = 4.0
FT IS BASED ON PT.

I. ADDL POSITIONS NIL

TOO: 12/1250EF=
NNNN

3 Hourly Satellite Bulletin



भारत मौसम विज्ञान विभाग
पृथ्वी विज्ञान मंत्रालय
India Meteorological Department
Ministry of Earth Sciences

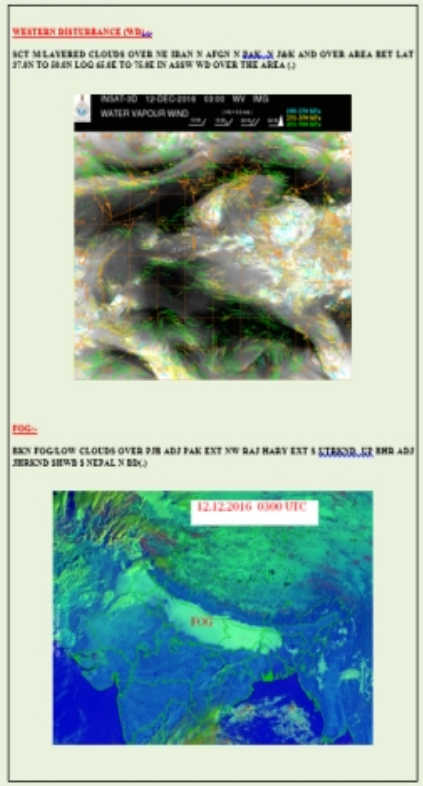
SATELLITE BULLETIN BASED ON SATELLITE IMAGERIES AND PRODUCTS
12.12.2016 TIME 0300 UTC

TCIN60 DEMS 120300
SATELLITE BULLETIN BASED ON INSAT 3DC OF 120300 UTC (.)
REGION COVERED BETWEEN LAT 40.0° N TO 30.0°S AND LONG 40.0°E TO 120.0°E (.)

SALIENT FEATURES:-

VORTEX OVER BOB (VARDAH):-

VORTEX (VARDAH) OVER WC BAY ADJ SW BAY CENTRED NEAR 13.2N/81.3E (.) INTENSITY T4.0 (.) CDO PATTERN (.) MINIMUM CTT MINUS 89 DEG C (.) ASSTD BKN LOW/MED CLOUDS WITH EMBDD INT TO V INT CONVTN OVER BAY BET LAT 11.5N TO 15.0N WEST OF LONG 81.5E & COTL AP N COTL TN (.)



WESTERN DISTURBANCE (WD):-

SCT M/LAYERED CLOUDS OVER NE IRAN N AFGN N PAK N J&K AND OVER AREA BET LAT 37.0N TO 39.0N LOG 65.0E TO 75.0E IN ASSW WD OVER THE AREA (.)

FOG:-

BKN FOG/LOW CLOUDS OVER PJB ADJ PAK EXT NW RAJ HARY EXT S UTTRKHD SE BHR ADJ JHRKHD SHWB S NEPAL N BD(.)

CLOUDS DESCRIPTIONS WITHIN INDIA:-

NORTH:-

SCT LOW/MED CLOUDS OVER BEST J&K N HP (.)

EAST:-

SCT LOW/MED CLOUDS WITH EMBDD ISOL WK CONVTN OVER S JHRKHD SW ORS SE CHTGH (.) SCT LOW/MED CLOUDS OVER SKM ARUPR S GWB BEST ORS AND BEST CHTGH (.)

WEST:-

SCT LOW/MED CLOUDS OVER VID (.)

SOUTH:-

BKN LOW/MED CLOUDS WITH EMBDD ISOL MOD TO INT CONVTN OVER COTL AP N COTL TN (.) SCT LOW/MED CLOUDS WITH EMBDD ISOL WK TO MOD CONVTN OVER BEST PARTS OF THE REGION EXCEPT SCT LOW/MED CLOUDS OVER KER (.)

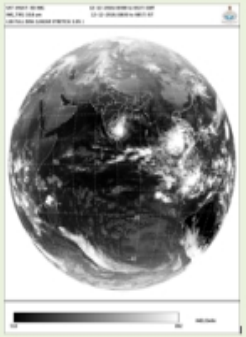
ARABIAN SEA:-

SCT LOW/MED CLOUDS WITH EMBDD WK TO MOD CONVTN OVER SE ARSEA OFF KER KRNTK COT (.)

BAY OF BENGAL & ANDAMAN SEA:-

SCT LOW/MED CLOUDS WITH EMBDD ISOL MOD TO INT CONVTN OVER ANDAMAN SEA (.)

CLOUDS DESCRIPTION OUTSIDE INDIA :-



R&D Work carried out:

- IMD has carried out a study for using RAPID and RGB imageries (Day Time Microphysics) for Nowcasting and identification of weather phenomena's by identifying their thresholds.

In day time micro physics RGB imagery **Fog** look like this

If Day-time Microphysics RGB is viewed and analyzed through RAPID, the **Fog pixels** value lies in the following range,

VIS Albedo	25 to 50 %
SWIR Albedo	35 to 60 %
TIR1	270°K to 290°K

In day time microphysics RGB imagery, **Low clouds** look like this.

If Day-time Microphysics RGB is viewed and analyzed through RAPID, the **Low clouds pixel** value lies in the following range,

VIS Albedo	30% to 45%
SWIR Albedo	40% to 60%
TIR1	255°K to 270 °K

In day time micro physics RGB imagery **Mid Level Orographic Cloud** look like this

If Day-time Microphysics RGB is viewed and analyzed through RAPID, the **Mid Level Orographic Cloud pixels** value lies in the following range,

VIS Albedo	30% to 50%
SWIR Albedo	40% to 60%
TIR1	245°K to 260 °K

In day time micro physics RGB imagery **CB cell** look like this

If Day-time Microphysics RGB is viewed and analyzed through RAPID, the **CB cell pixels** values lies in the following range,

VIS Albedo	>50 %
SWIR Albedo	<25 %
TIR1	<245°K

In day time micro physics RGB imagery **Snow** look like this

If Day-time Microphysics RGB is viewed and analyzed through RAPID, the **Snow pixels** value lies in the following range,

VIS Albedo	>35 %
SWIR Albedo	<20 %
TIR1	260°K to 280 °K

In day time micro physics RGB imagery **Sand / Dust** look like this

If Day-time Microphysics RGB is viewed and analyzed through RAPID, the **Sand / Dust pixels** value lies in the following range,

	Sand	**Dust**
VIS Albedo	20% to 30%	20% to 30%
SWIR Albedo	40% to 70%	30% to 40%
TIR1	290°K to 320 °K	275°K to 295 °K

R&D Work carried out:

- IMD has carried out a study for using RAPID and RGB imageries (Night Time Microphysics) for Nowcasting and identification of weather phenomena's by identifying their thresholds.

In night time microphysics RGB imagery, **Fog** look like this

If Night-time Microphysics RGB is viewed and analyzed through RAPID, the **Fog pixel** value lies in the following range,

TIR2BT – TIR1BT	Negative value
TIR1BT - MIRBT	>2.5°K
TIR1BT	270°K to 290°K

The 3.9 µm channel is subject to noise at very cold temperatures. Fog at high latitudes in winter may have noise in the pixels representing fog. Similarly, the depiction of very high, cold clouds (i.e. cumulonimbus tops) will have yellow pixels mixed in areas of dark red for this RGB due to the 3.9 µm channel noise at such temperatures.

In night time microphysics RGB imagery, **Low clouds** look like this.

If Night-time Microphysics RGB is viewed and analyzed through RAPID, the **Low clouds pixel** value lies in the following range,

TIR2BT – TIR1BT	Positive
TIR1BT - MIRBT	Positive
TIR1BT	250°K to 265°K

In night time microphysics RGB imagery, **Medium clouds** look like this.

If Night-time Microphysics RGB is viewed and analyzed through RAPID, the **Medium clouds pixel** value lies in the following range,

TIR2BT – TIR1BT	Positive
TIR1BT - MIRBT	Positive
TIR1BT	245°K to 260°K

In night time microphysics RGB imagery, **CB Cell** look like this

If Night-time Microphysics RGB is viewed and analyzed through RAPID, the **CB Cell pixel** value lies in the following range,

TIR2BT – TIR1BT	Positive
TIR1BT - MIRBT	Negative
TIR1BT	<245°K

In night time microphysics RGB imagery, **Snow** look like this.

If Night-time Microphysics RGB is viewed and analyzed through RAPID, the **Snow pixel** value lies in the following range,

TIR2BT – TIR1BT	Negative
TIR1BT - MIRBT	Negative
TIR1BT	260°K to 290°K

In night time microphysics RGB imagery, **Sand / Dust** look like this.

If Night-time Microphysics RGB is viewed and analyzed through RAPID, the **Sand / Dust pixel** value lies in the following range,

	Sand	**Dust**
TIR2BT – TIR1BT	Negative	Negative
TIR1BT - MIRBT	Negative	Negative
TIR1BT	280°K to 290°K	275°K to 285°K

However these ranges may vary from place to place and over time, user may work out the values of their areas.

Key issues of relevance to CGMS:

- IPWG Rapporteur to liaise with IMD (AK Sharma) on the development of precipitation validation sites over India action ref. no. A44.03 WGII/4.

  IMD has already given consent to host precipitation validation site to WMO vide email dated 13-04-2017 to Mr.Ralaph Ferraro /Dr Raaj Ramasankaran and is waiting for response from the concerned Scientist to provide necessary software and interface to set up the validation site. Focal point from IMD is Dr. S K Peshin, Head (SATMET)/Scientist-G.

- IMD to provide more information (documentation, availability details, URL) about the RAPID tool , for inclusion in the WMO webpage on Visualization Tools to CGMSSEC action ref. no. A44.08 WGII/6.

  IMD has provided the RAPID User Guide vide email dated 01st May 2017.

- CGMS agencies to make available a non real-time cache of satellite level 1 data over the previous 2-3 months, similar to the NOAA CLASS system action ref. no. R43.07 WGII/10.

  This action will be closed after establishment of MMDRPS in March 2018.

To be considered by CGMS:

- Explore the possibility implementing arrangement with NOAA/EUMETSAT in terms of data sharing and application algorithm development
- **IMD propose to have close collaboration regarding Cal/val site development with CMA**

THANKS