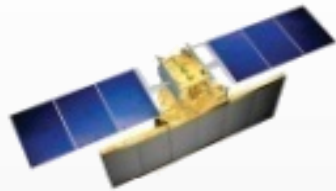




Vision: Harness space technology for national development, while pursuing space science research and planetary exploration

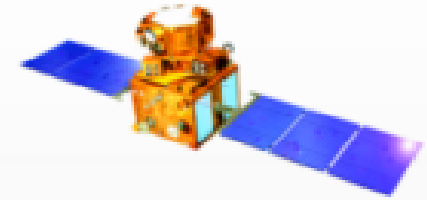


Space Applications

- Synergistic Applications – EO, SatCom & Navigation
- National Development Projects
- Land-Ocean-Atmos Interactions

Space Infrastructure

- Earth Observation
- Communication
- Navigation
- Space Science & Planetary Missions



Capacity building

- Human Resource Develop.
- Indigenization
- Technical Infrastructure
- International Cooperation
- Industry, Academia
- Outreach



Space Transportation

- PSLV
- GSLV
- Reusable LV
- Human Space Flight

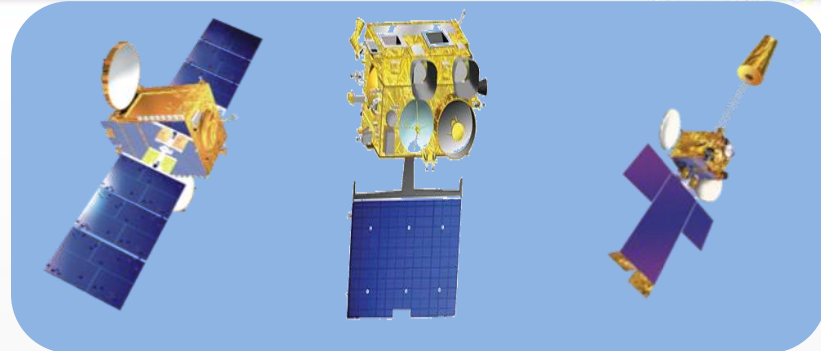




Communication Satellites

- **14 Operational**

INSAT-3A, 3C, 4A, 4B, 4CR
GSAT-6, 7, 8, 10, 12, 14, 15, 16 & 18



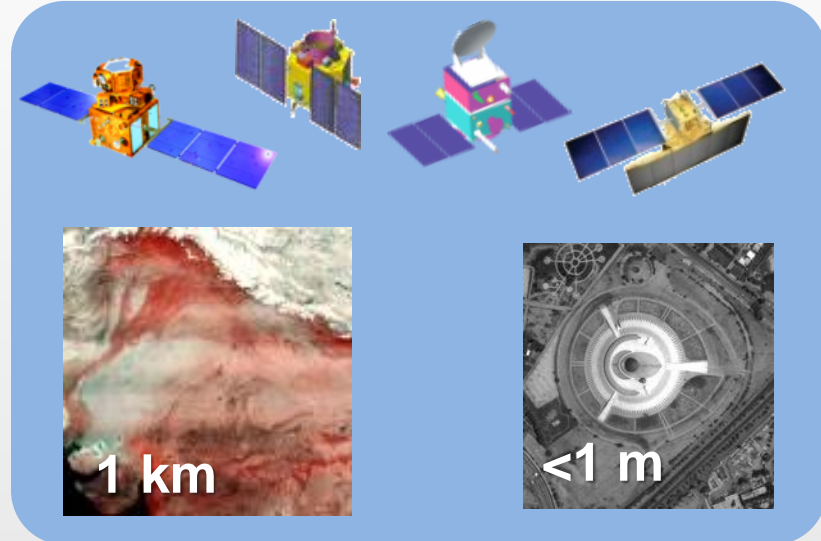
Earth Observation Satellites

- **Four in Geostationary orbit**

INSAT-3D, Kalpana, INSAT-3A & INSAT-3DR

- **12 in Sun-synchronous orbit**

RESOURCESAT-2; CARTOSAT-1, CARTOSAT-2 series (4 Nos.) RISAT-1, RISAT-2, OCEANSAT-2, MEGHA-TROPIQUES, SARAL SCATSAT-1

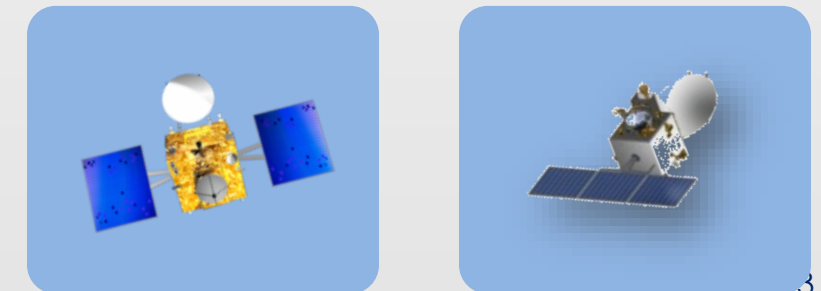


Navigation Satellites (NavIC)

- **Full Constellation of 7 satellites realized**

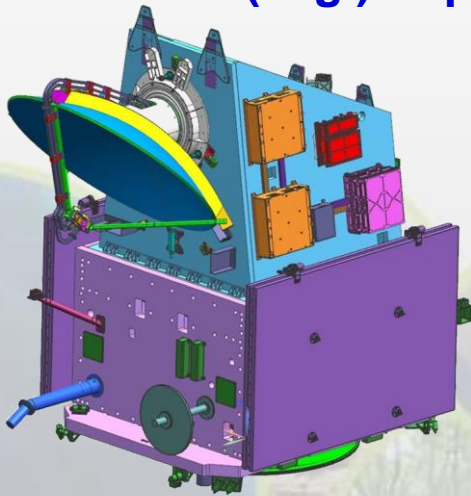
Space Science

- **MOM & ASTROSAT**





- Cartosat-2 Series on June 22, 2016 - advanced EO satellite with sub-meter resolution
- INSAT – 3DR on Sept 08, 2016 – repeat of advanced weather satellite of India configured with improved Imaging System and Atmospheric Sounder
- Scatsat-1 (kg/) Sept 26, 2016 - Dedicated Ku Band Scatterometer mission



SCATSAT



CARTOSAT-2S

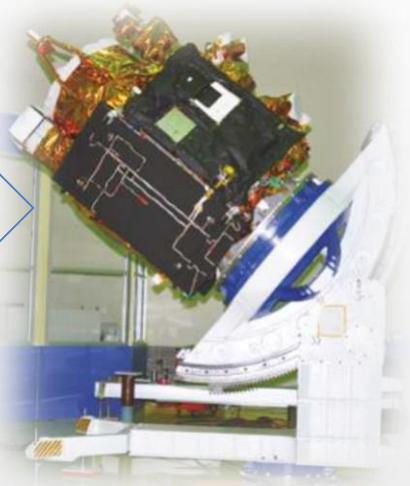


INSAT-3DR



**20 Satellites
launched in one mission**

**Cartosat-2
Series**



Cartosat-2 Series is an advanced EO satellite with very high resolution Panchromatic (sub-meter) & Multispectral (2m) Cameras

**PSLV-C34 Lift-off
June 22, 2016**

19 Co-passenger Satellites



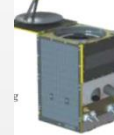
LAPAN-A3 Indonesia
(Earth Observation)



BIROS Germany
(RS of High Temperature events)



M3MSAT Canada
(Study AIS signals from LEO)



SKYSAT-Gen2-1 USA
(Sub-meter resolution EO)



GHGSAT-D Canada
(Atm. GHG measurement)



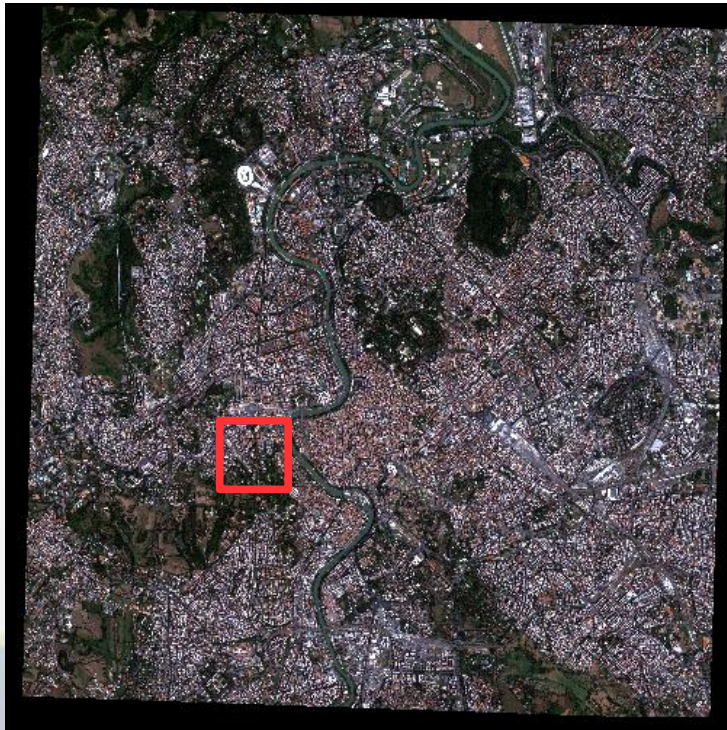
DOVE (12 Sats.) USA
(Earth Observation)



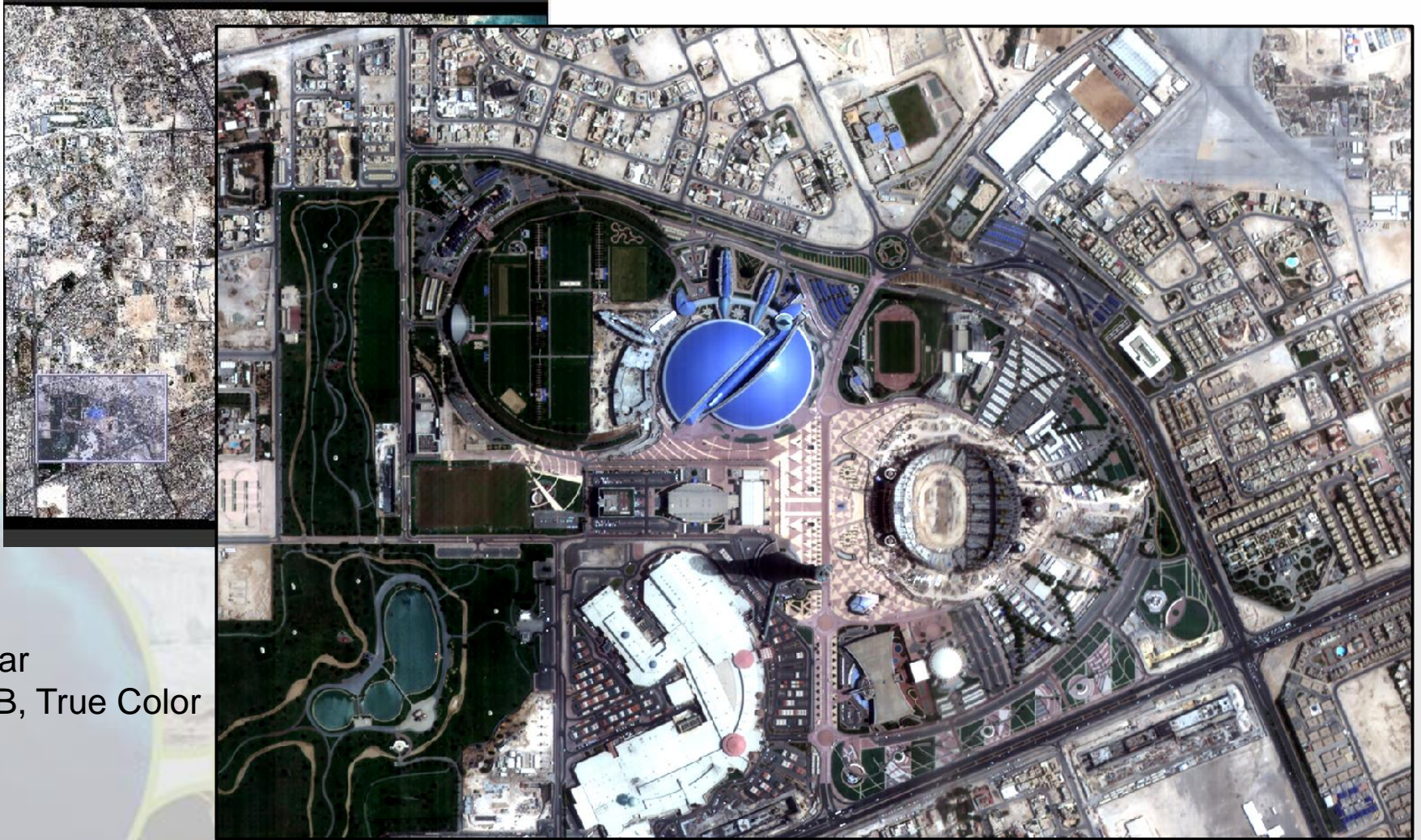
**SATYABAMASAT
Satyabama Uni.**
(GHG data collection)



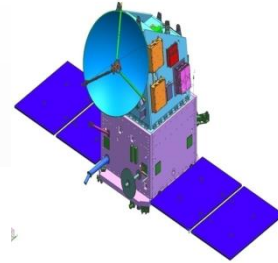
**SWAYAM
College of Engineering ,Pune**
(point to point messaging for HAM)



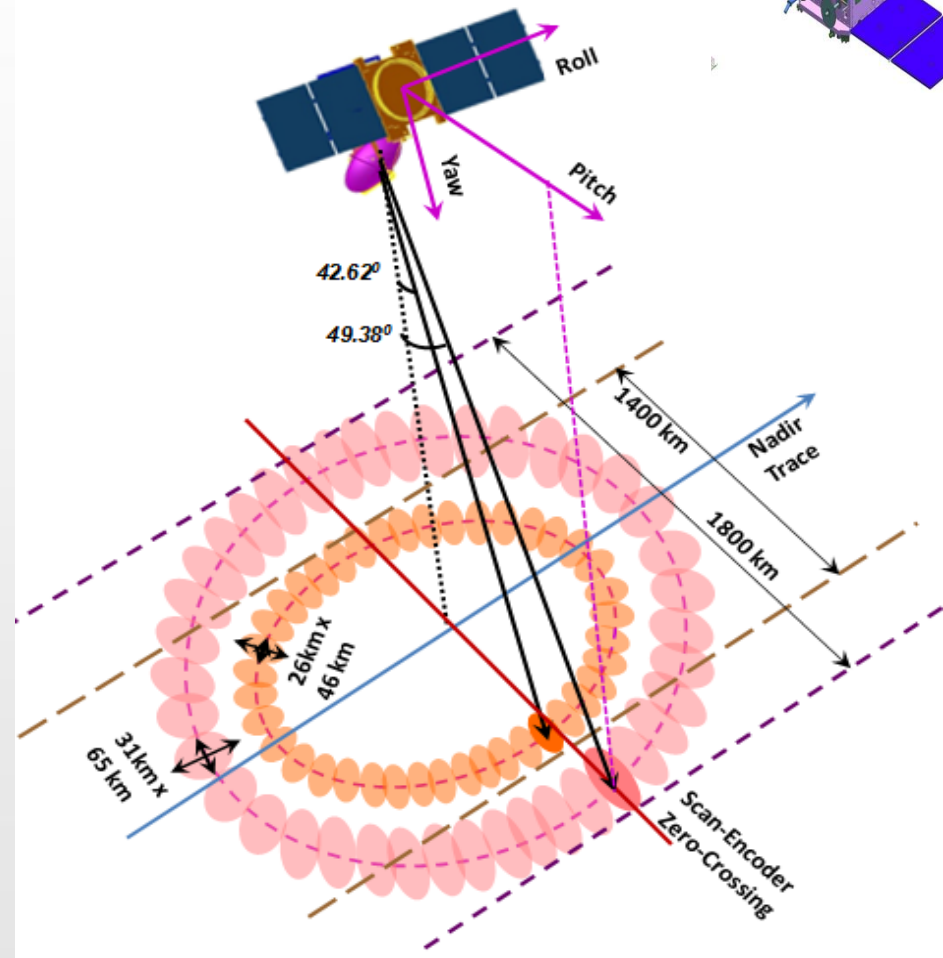
Vatican City
RGB, True Color
(PAN+MX Merged at
0.6m)



Qatar
RGB, True Color



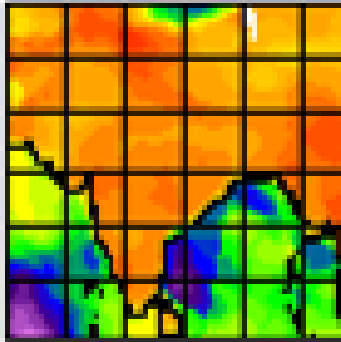
Orbit Period (min)	26 Sep 2016
Payload	Ku band Scatterometer
Spacecraft Class	IMS-2
Spacecraft Mass	~370 kg (P/L : 110 kg)
Spacecraft Power	Nominal: 295 W; Peak: 312 W
Mission Life	5 years
Orbit type	Non Sun-Synchronous at launch Sun-Synchronous after 3-6 months
Launch Vehicle	PSLV
Frequency	13.5 GHz
Number of orbits / day	14 ½
Altitude (kms)	720
Inclination	98.29
ECT Descending node	08:45 AM LT (~Currently 09:18 AM)
	99.19 min
repeat cycle / Revisit	2 days



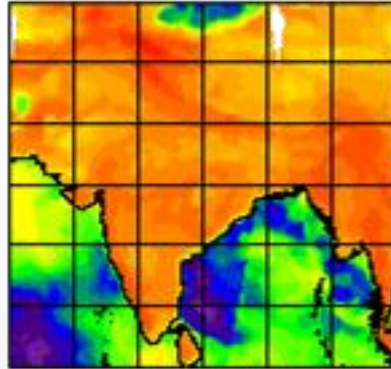


Combined VV Products at various resolutions

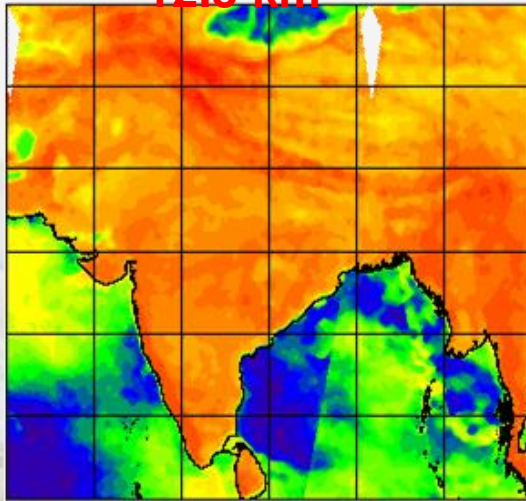
50 km



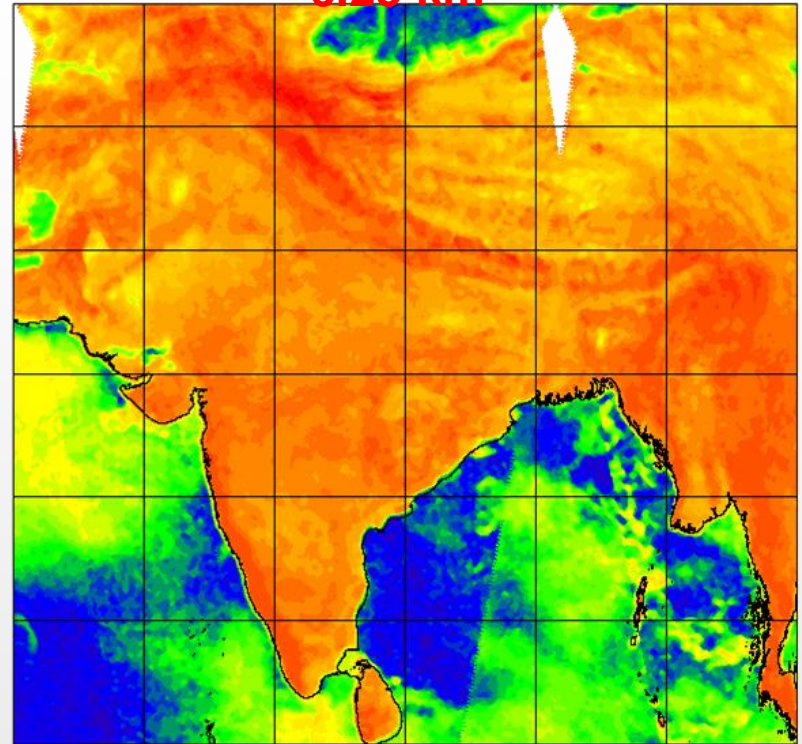
25 km

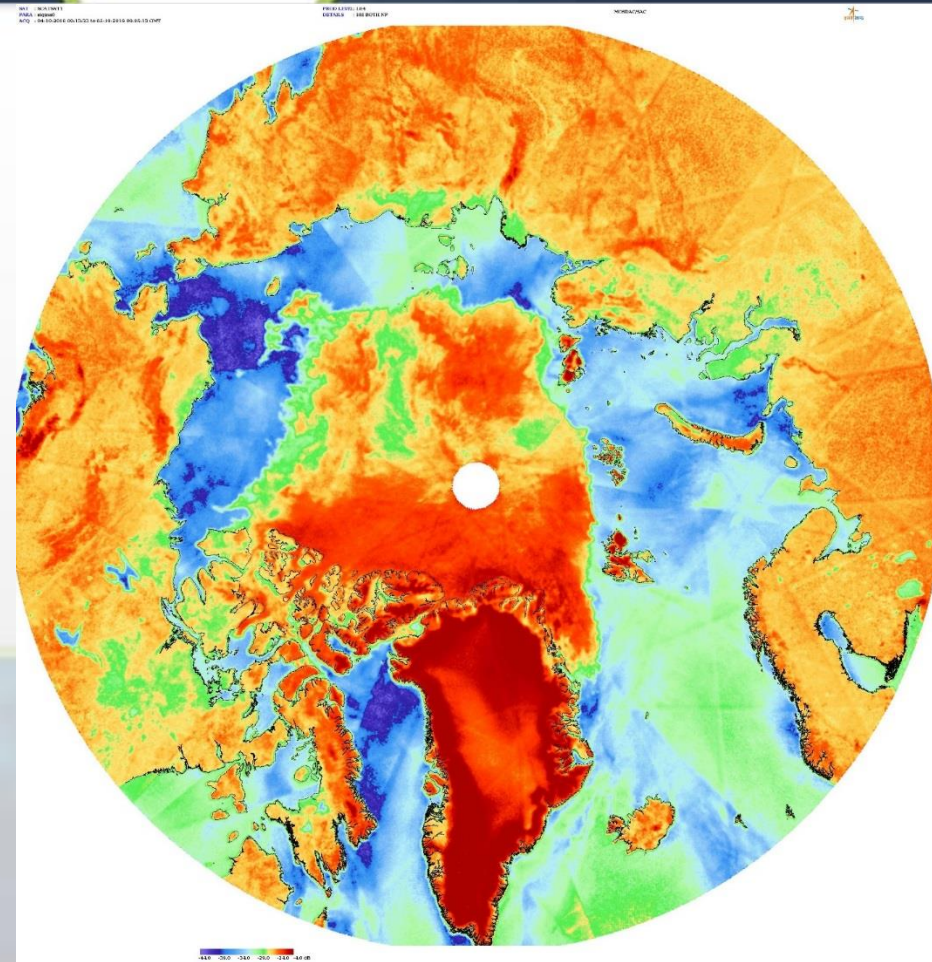


12.5 km

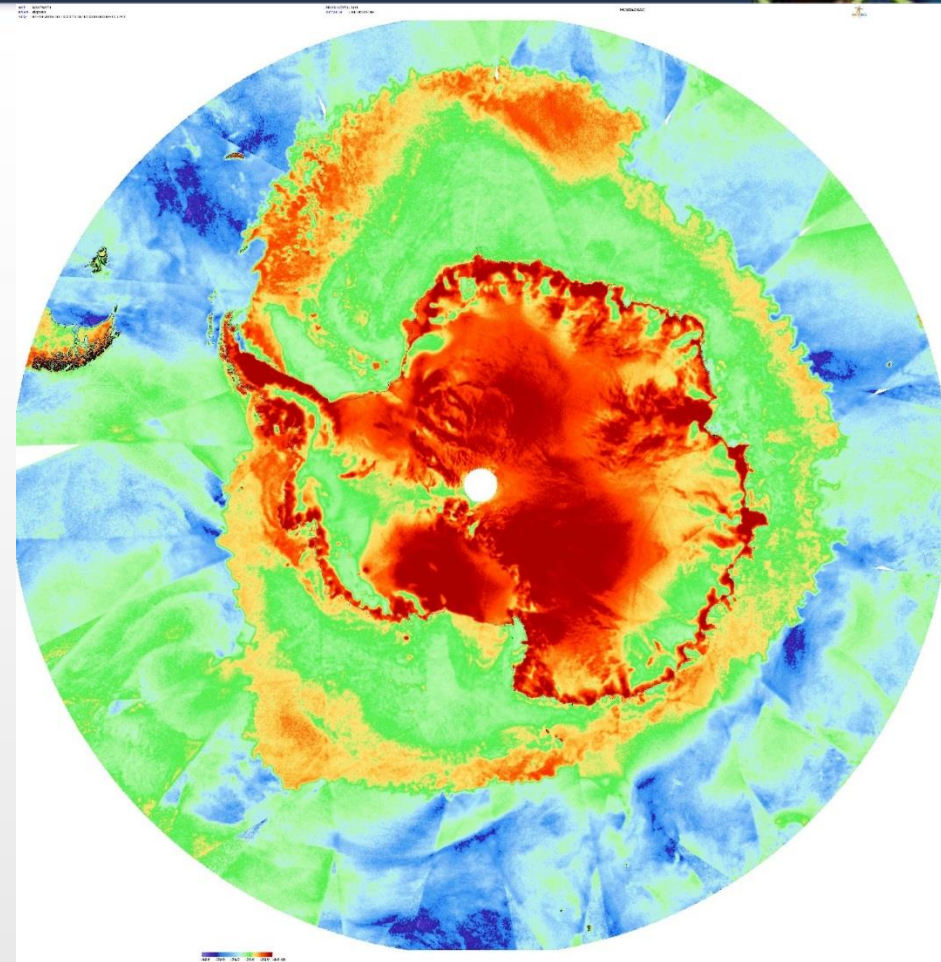


6.25 km





Arctic

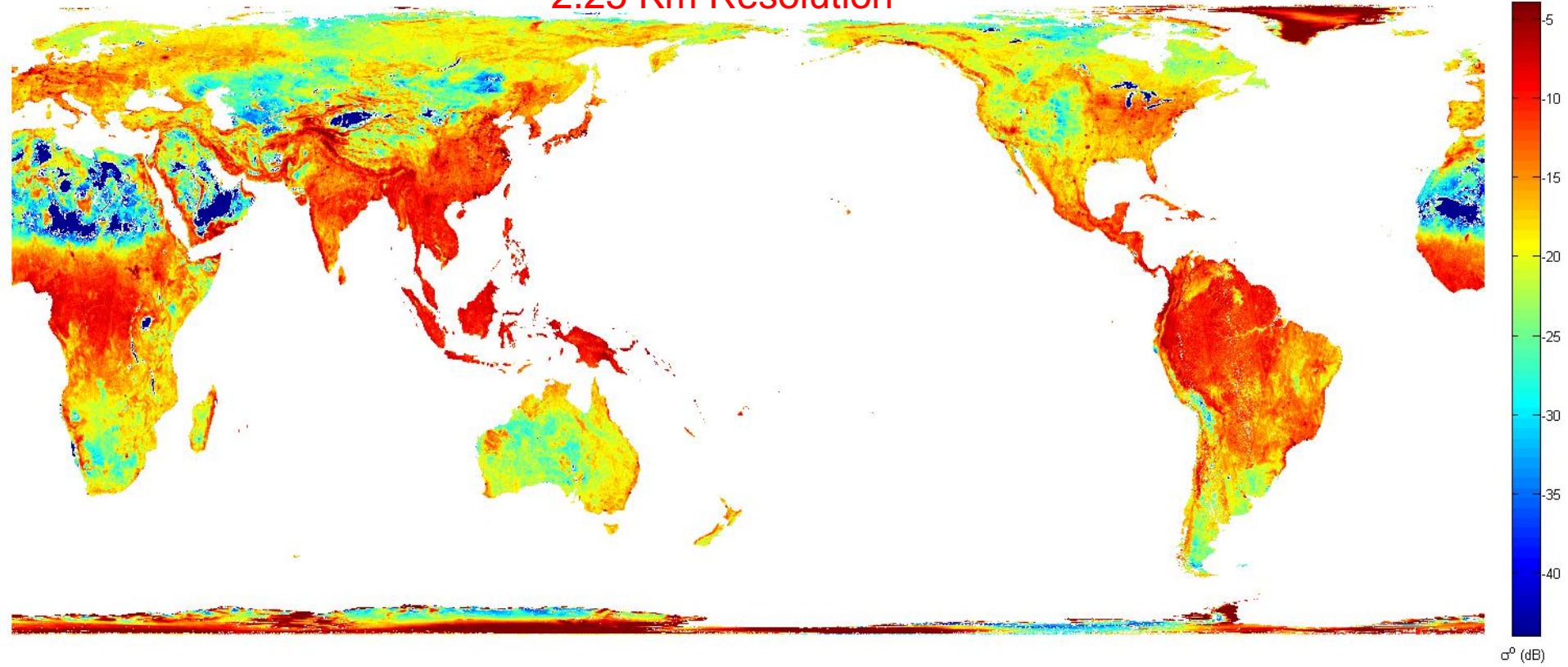


Antarctic

HH Pol

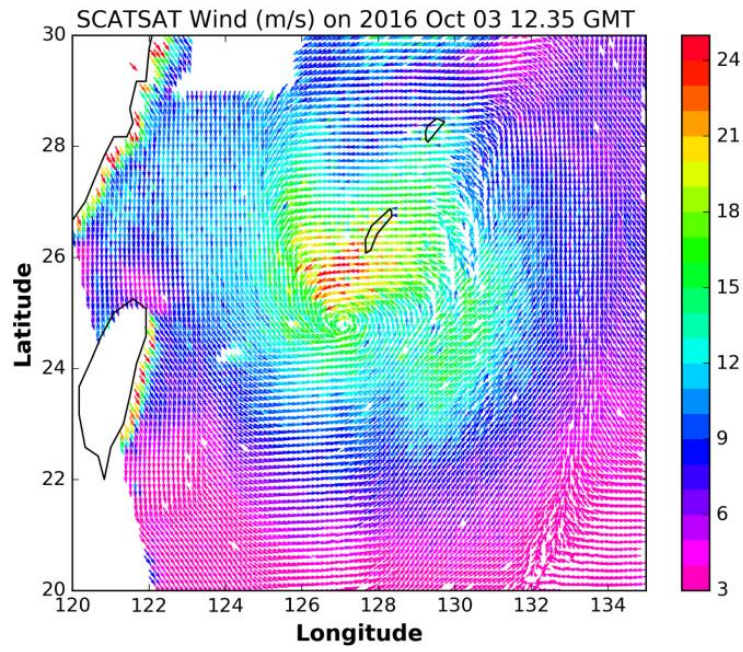


2.25 Km Resolution

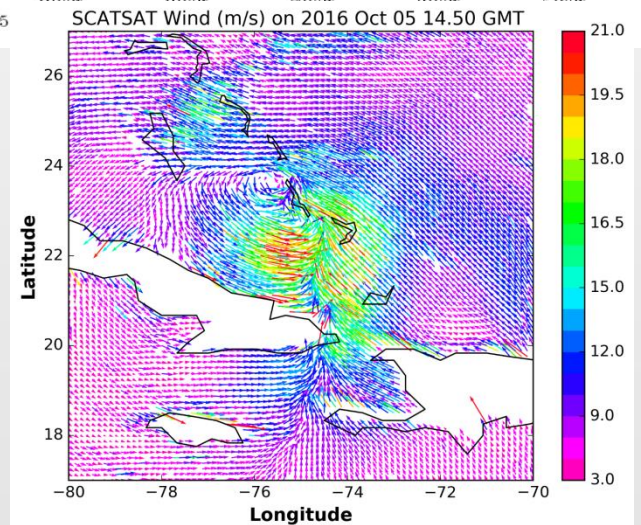
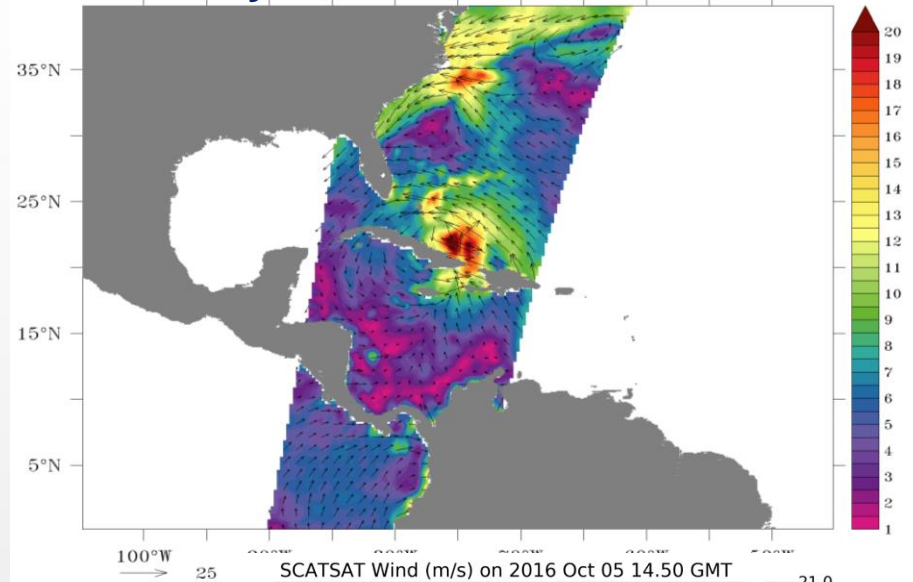




**Hurricane Chaba, Near South Korea Coast
(Scatsat-1: October 03, 2016 12.35 GMT)**



Hurricane Matthew, Near US Coast as observed by Scatsat-1, 1450 GMT Oct 05, 2016



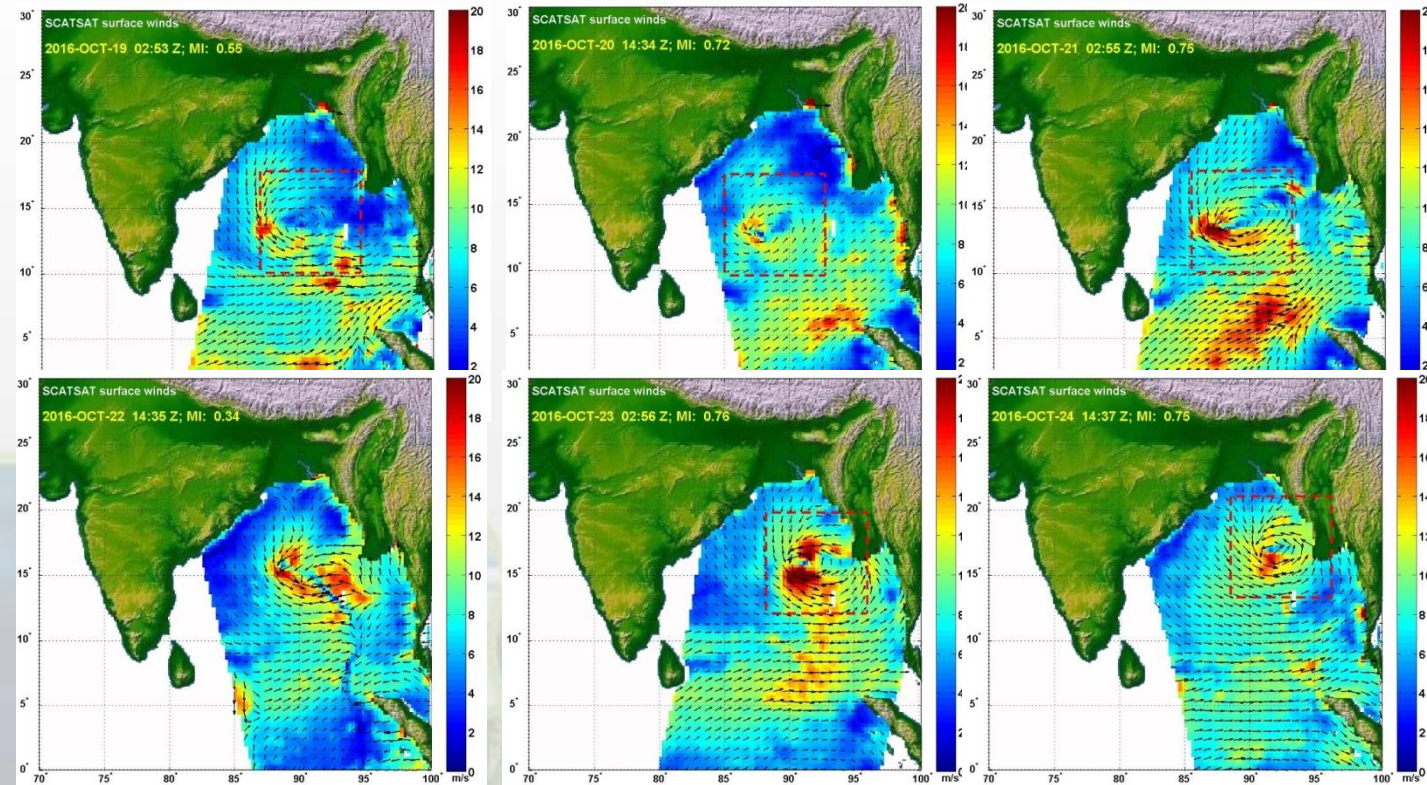
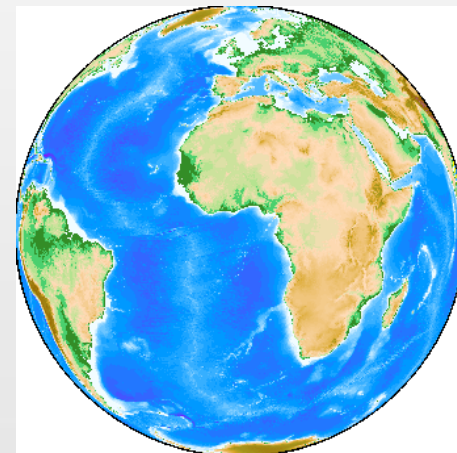
Tropical Cyclogenesis of Tropical cyclone KYANT (Bay of Bengal)



**TC Formation:
25 OCT 00 Z**

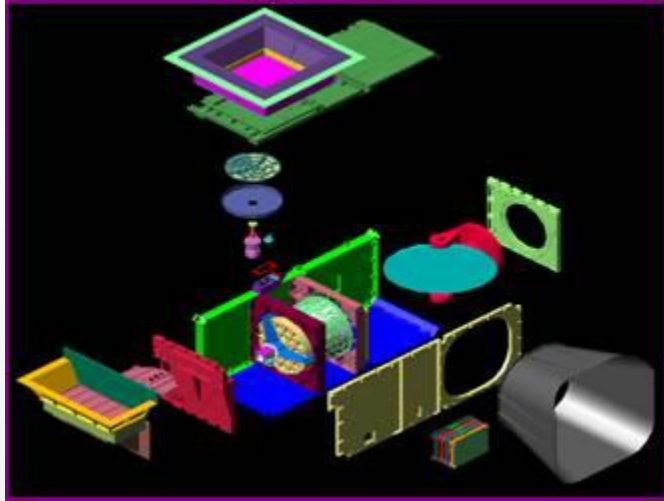
**Cyclogenesis
Prediction:
19 OCT 03 Z**

**Lead Prediction
time: 140 Hrs**



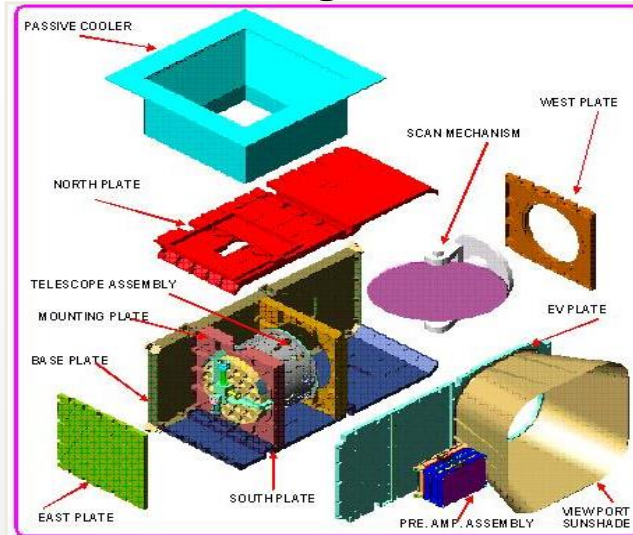


Sounder

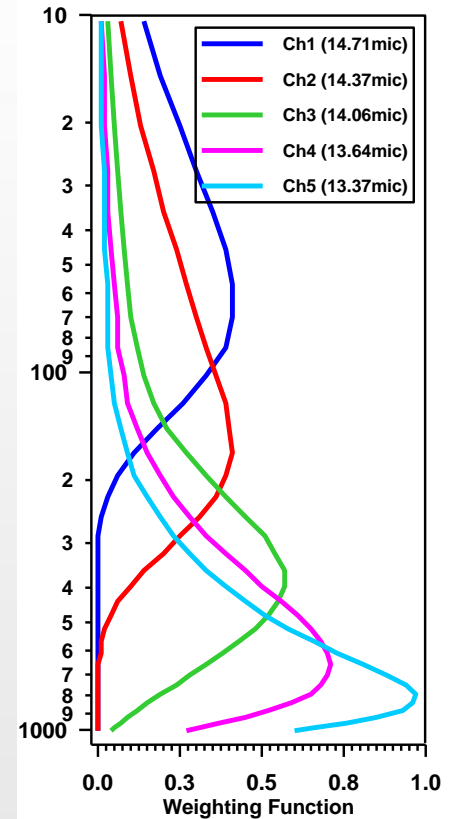


19 channel Sounder

Imager



Advanced 6-channel imager



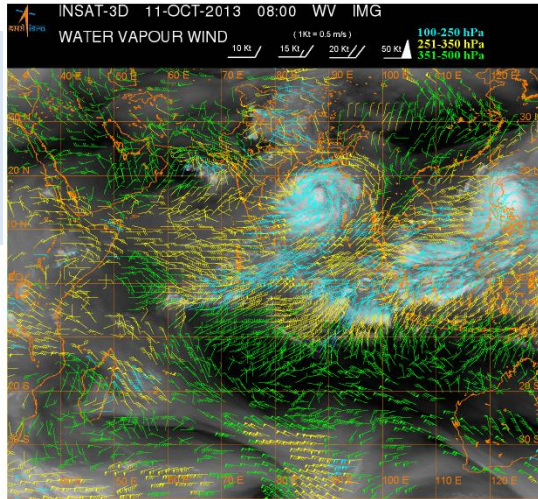
INSAT-3D Weighting function over Indian Region (July)

Sensor	Bands (μm)	Spatial Res.
Imager	VIS (0.55-0.75), SWIR (1.55-1.70)	1km x 1km
	MIR (3.8-4.0)	4km x 4km
	WV (6.5-7.1)	8km x 8km
	TIR1 (10.2-11.3), TIR2(11.5-12.5)	4km x 4km
Sounder	19 channels	10km x 10km

Applications: Improved estimation of water vapour content, cloud, wind vector, upper tropospheric humidity, sea surface temperature and surface insolation



More accurate Atmospheric Winds from INSAT-3D/3DR Combination

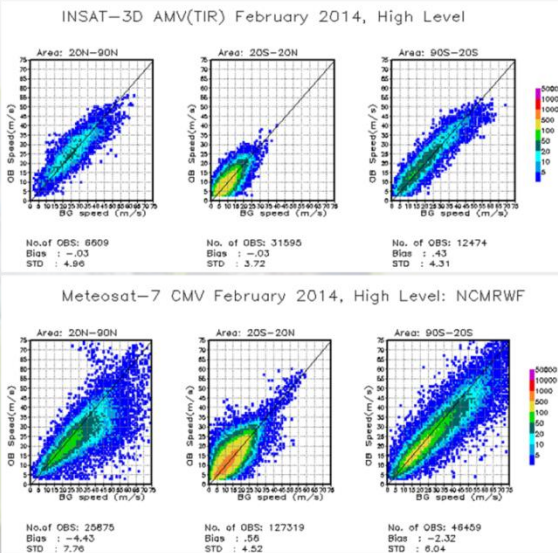


AMV : Comparison with First Guess (Upper Level)

Current status of INSAT-3D winds With respect to Meteosat-7.

INSAT-winds are likely to improve further due to INSAT-3DR

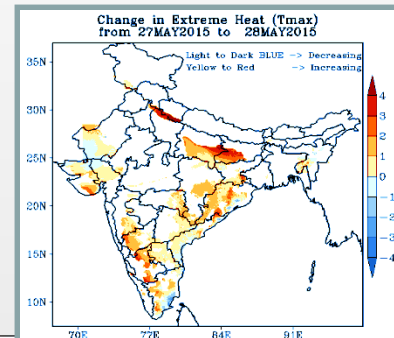
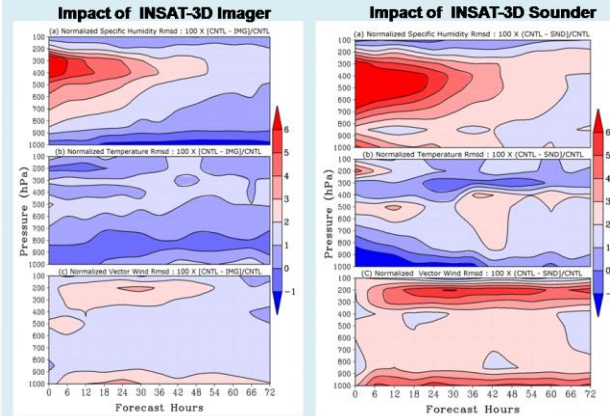
INSAT-3D Winds are continuously being assimilated in IMD/NCMRWF Models



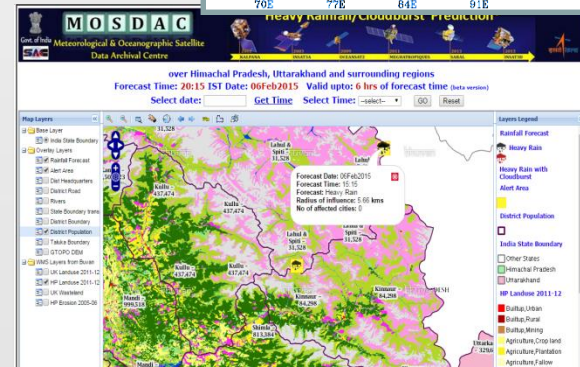
INSAT-3D

Meteosat-7

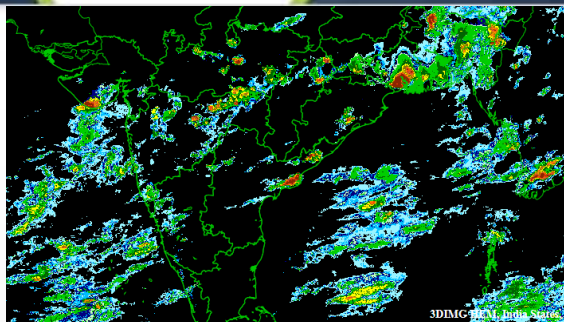
Assimilation of INSAT-3D Radiances % Improvements in Forecasts with Assimilation of INSAT-3D Radiances



Heat-wave monitoring & prediction



Nowcasting of extreme weather



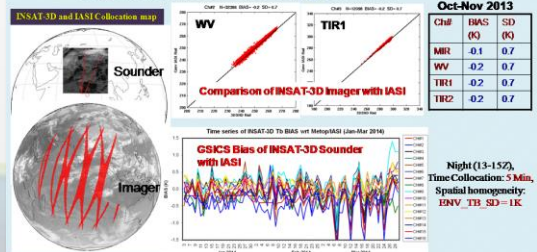
Monitoring of extreme rain events

GSICS Intercalibration of INSAT-3D Imager and Sounder

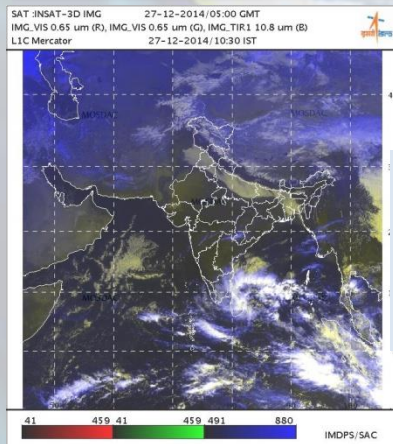
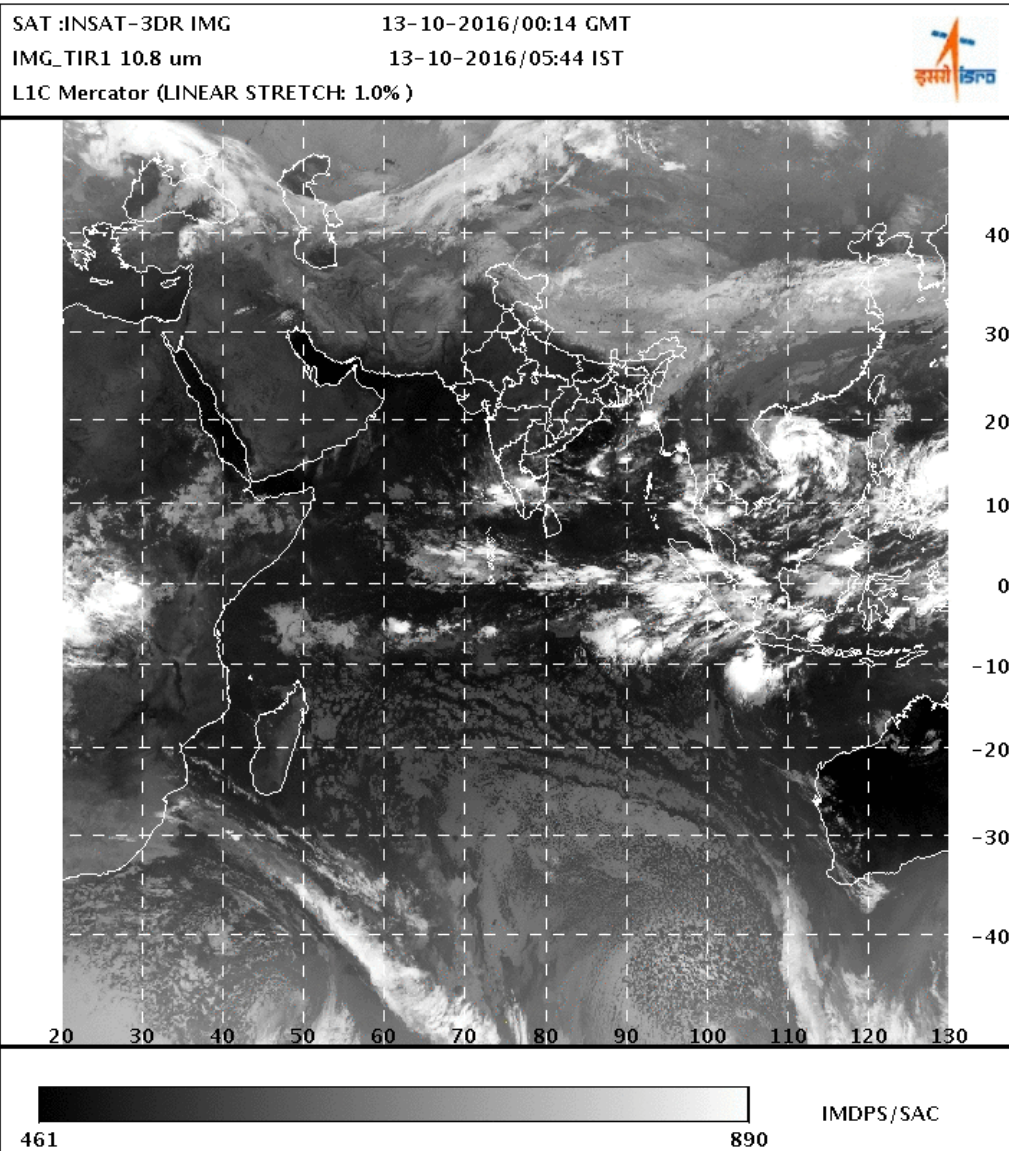


Reference instruments: Hyperspectral sounder IASI/MetOp (EUMETCAST at SAC Bopal camp)

Procedure: Collocation in space, time, observation zenith angle over homogenous scene condition. Convolve hyperspectral radiance over INSAT-3D using SRFs as weight. Validation of the procedure for GOES-13 Imager and Sounder



Inter-satellite Calibration GSICS



Tropical Cyclone monitoring & prediction



- India's first multi-wavelength Observatory in Space
- Simultaneous observations in Optical, Ultraviolet, Low & High energy X-Ray regions to study Stars and Galaxies
- Opportunity to task observations for scientific community

Comparison of NGC 2336 by ASTROSAT with GALEX image

Galaxy Evolution Explorer (GALEX) Mission of NASA

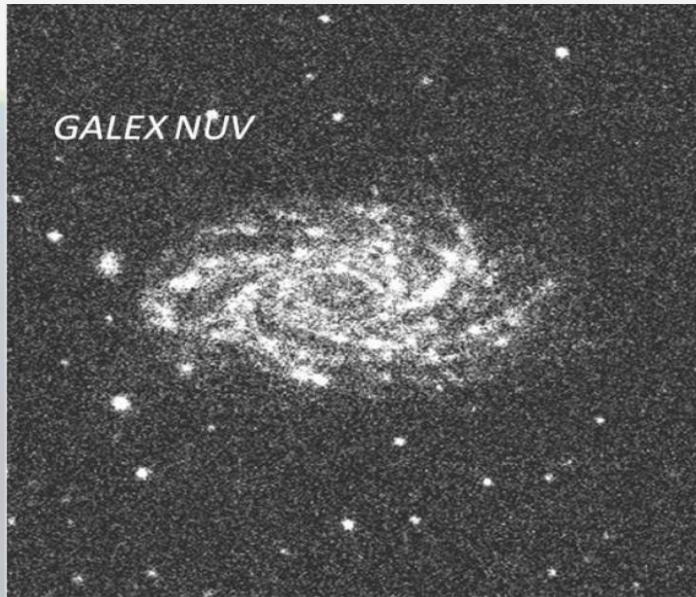


Image resolution of 6 arcsec

1 The nearby Galaxy is resolved.

2 The spiral arms are clearly visible and well separated.

Indian ASTROSAT Mission

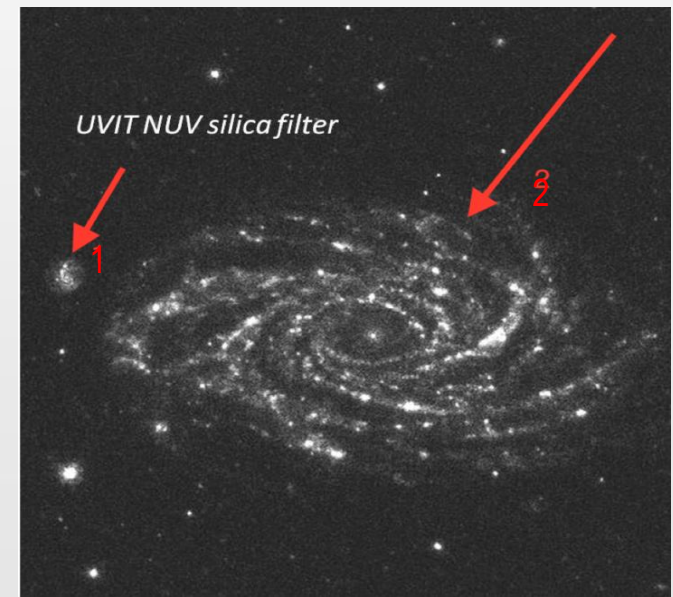


Image resolution of 2 arcsec



Application Sectors

Aviation



Railways



Roadways



Maritime



Navigation



Survey





Vedas



Bhuvan



MOSDAC



Decision Support Centre India-Water Resources Info. System



Forest Fire Info. System



BHUVAN Geoportal – A National Geospatial Engine

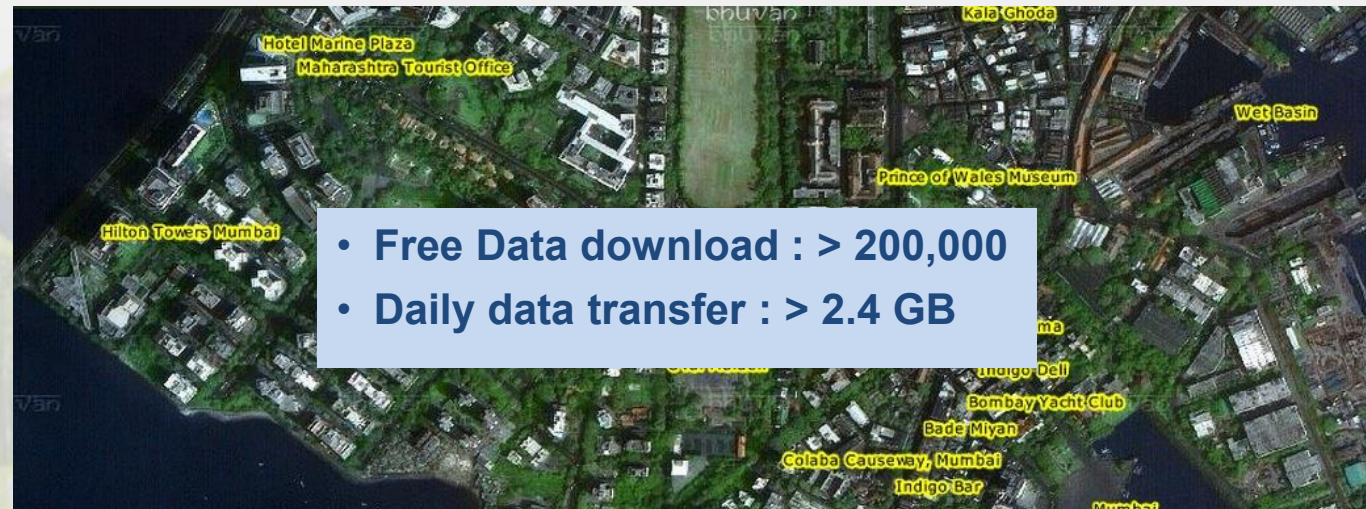


- Visualisation
- Thematic Maps (WMS)
- Open Data (for download)
- User Data Site
- Crowdsourcing

2D, 3D, on mobile

Data Downloads
LISS_III, AWIFS,
CartoDSM (30m)

- Online Disaster Support
- Central/ State Ministries
- Crop Pest Surveillance



- Free Data download : > 200,000
- Daily data transfer : > 2.4 GB



Nov. 2016

RESOURCESAT-2A Continuity for Resourcesat-2

- LISS 4 (5.8 m, 70 km swath, 10 bit)
- LISS 3 (23 m, 141 km swath, 10 bit)
- AWiFS (56 m, 800 km swath, 12 bit)

Orbit : 817 km

Local time: 1030 hrs



2017

CARTOSAT- 2D & 2E VHR Panchromatic and Multispectral Imaging

- PAN (0.60 m, 10 km swath, 11 bit)
- Mx (2m , 10 km swath, 4 Xs, 11 bit)

Orbit : 500 km

Local time: 0930 hrs



2018

GISAT - 1 Geosynchronous Orbit

- HR Mx VNIR : 50m; SWIR: 1.5 Km
- HYSI VNIR: 320m; WIR : 192m

Orbit : 36000 km

Every 30 min



2018

CARTOSAT-3 VHR Panchromatic, Multispectral Imaging



- PAN (0.25 m, 16 km swath, 11 bit)
- Mx (1m , 16 km swath, 11 bit)

Orbit : 450 km

Local time: 1030 hrs

2018 & 2019

Oceansat-3 & 3A Continuity for OS-2 with Improvements

- 13 band OCM, IR-SST
- Ku-band Scatterometer ,

Orbit : 720 km

Local time: 1200 hrs



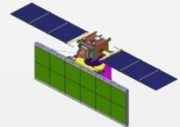
2018

RISAT-1A Continuity for RISAT-1

- C-Band SAR

Orbit : 536 km

Local time: 0600 hrs



2019 & 2020

RESOURCESAT- 3 & 3A Continuity for Resourcesat-2A

- ALISS-3:10m & 12m, 925 km, 5 Bands, ATCOR: 240m, 0.4-1µm, , 10 bit)

Orbit : 795 km

Local time: 1030 hrs



2019 & 2020

RS SAMPLER- 3S & 3SA High Res. Stereo imaging

- PAN Fore & AFT
- APAN: 1.25m, 60Km
- Mx: 2.5m, 60Km, 4 Bands

Orbit : 630 km

Local time: 1030 hrs



2020

NISAR Joint Mission with JPL/NASA Payloads

- L & S Band SAR

Orbit : 747 km

Local time: 0600 hrs





THANK YOU