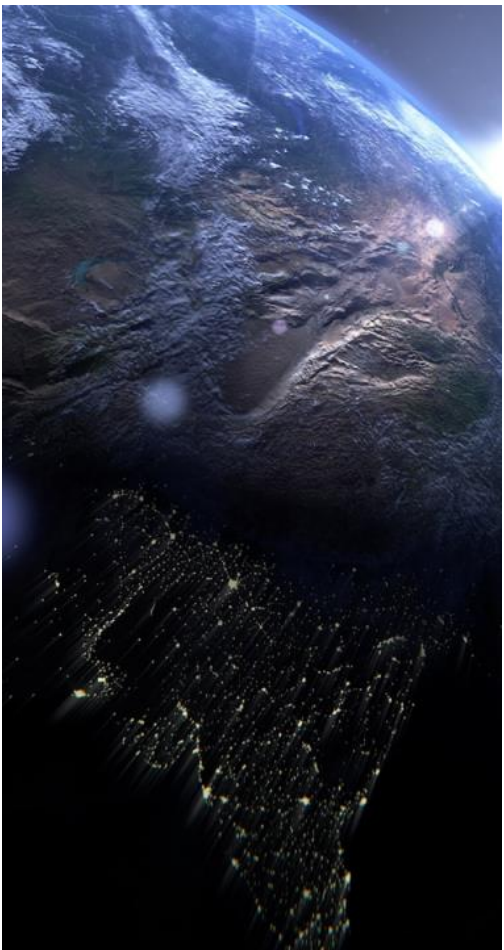




Overview of Space-based Earth Observation Programmes

Babu Govindha Raj K
Deputy Director, EDPO
ISRO HQ

WMO – ITU Spectrum Use for Meteorology



The Indian Space Policy – 2023 has been formulated as an overarching, composite and dynamic framework to implement the reform vision approved by Cabinet in April 2023.

- ❖ First of its kind policy – making Indian Remote Sensing Satellite (IRS) data both current/future and archived data since 1988 having 5m and coarser spatial resolution available on ‘free and open’ basis to all.
- ❖ Data dissemination through ISRO portals, Bhoonidhi portal (<https://bhoonidhi.nrsc.gov.in>) & MOSDAC(<https://mosdac.gov.in>).
- ❖ The products are radiometrically and geometrically corrected.
- ❖ The data can be freely used, reused and redistributed by anyone to improve availability of IRS data for National & Global use, with due credit to DOS/ISRO.

- ❖ **Meteorological series satellite data, already available on open basis, shall be continued on the same lines.**
- ❖ Any resolution IRS Data (produced using public funds) - “free of any charges” to Indian Government agencies.
- ❖ Thematic data derived from IRS satellite data of coarser 5m resolution shall be made available on ‘free and open basis’ to all.
 - 1) Landuse / Landcover
 - 2) Forest Cover
 - 3) DEM (30 m and coarser)
 - 4) Vegetation & Water indices

Remote Sensing Capabilities : ISRO

Natural Resources Inventory & Disaster Management

**RESOURCESAT- 2 & 2A, RISAT-1A,
NISAR**

Large Scale Mapping, Infrastru. Planning & Cartography

CARTOSAT- 2S & CARTOSAT-3

Oceanography

OCEANSAT-3 & SARAL

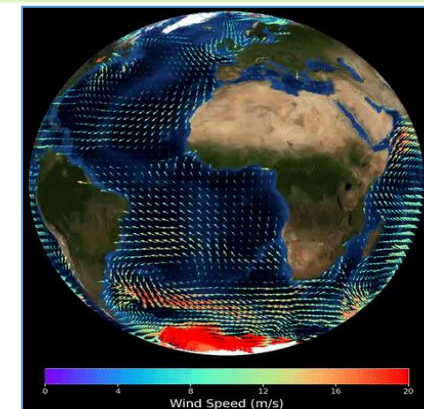
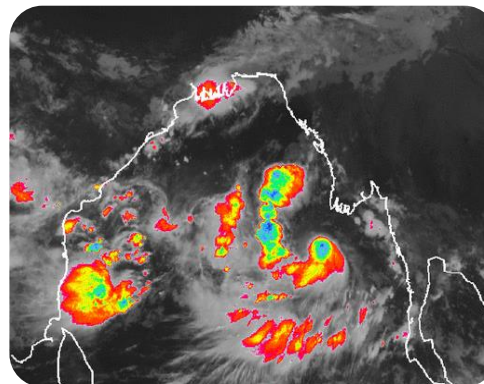
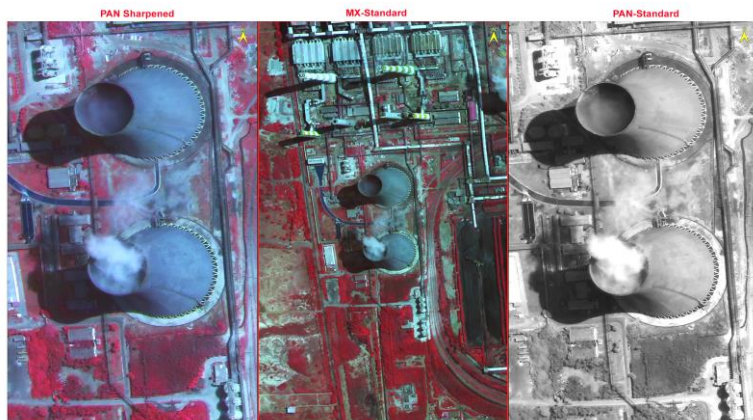
Weather & Climate

INSAT 3DR & 3DS

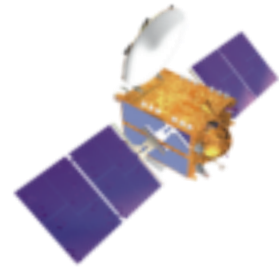
- Three tier imaging : 56 m / 23 m / 5.8 m
- Revisit Capability : 03 / 11 / 03 days
- Microwave SAR imaging in multi mode
- Sub-meter PAN and 1.5 m Multi-spectral
- 0.50 m PAN
- 0.30 m PAN CS-3
- Ocean Color 360 m with 2 days revisit
- Global Wind Vector from Scat
- 6 channel Imager – 48 images per day
- 19 Channel Sounder – Atm. Profiles

Major Applications

- Natural Resources Census
- Agricultural Crop Inventory
- Wasteland Mapping & Change
- Watershed Development
- Forest Mapping & Biodiversity
- Surface & Ground Water
- Command Area Monitoring
- Irrigation Infrastructure
- Reservoir Capacity Evaluation
- Snow-melt Run-off Estimation
- Wetlands, Mangroves, Coral Mapping, Coastal Maps
- Agricultural Drought Assessment
- Urban Information System
- Potential Fishing Zone Advisories
- Primary Production
- Ocean State Forecast
- Ocean Surface Winds
- Ocean Altimetry
- Monitoring of reservoir water levels
- Weather Forecasting
- Cyclone Intensity, Track & Landfall
- Extreme Rainfall
- Heat & Cold Wave



Domains of Earth Observation Applications



Water Resources Assessment

Potential Fishing Zones

Renewable energy

Weather, Agromet & Forest

Tele-medicine and Tele-education

Natural Res. Management

NavIC services

Irrigation Infrastructure - PMKSY

Rural Employment - MGNREGA

Housing Schemes - PMAY

Rural Roads - PMGSY

Decentralized Planning

Crop Insurance - PMFBY

Decision Support
Planning & Monitoring

Socio-economic Security, Natural Resources etc.

**Sustainable
Development**

Governance

**Disaster Risk
Reduction**

Early Warning
Detection & Monitoring



Flood, Cyclone, Landslide, forest fire, Drought

Multi-Scale National Database

Early Warning System

Hazard Assessment & Zonation

NRT Monitoring & Damage Assessment

Enabling ICR-ER Creation

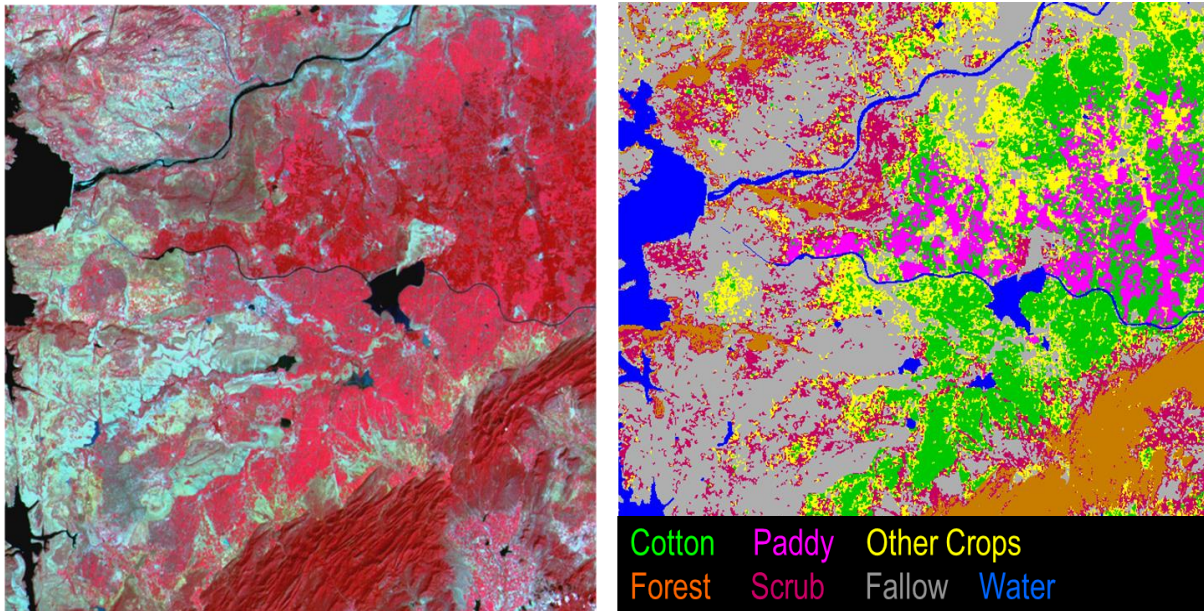
International Charter & Sentinel Asia

Geoportals for Visualization, Analytics & Information Dissemination

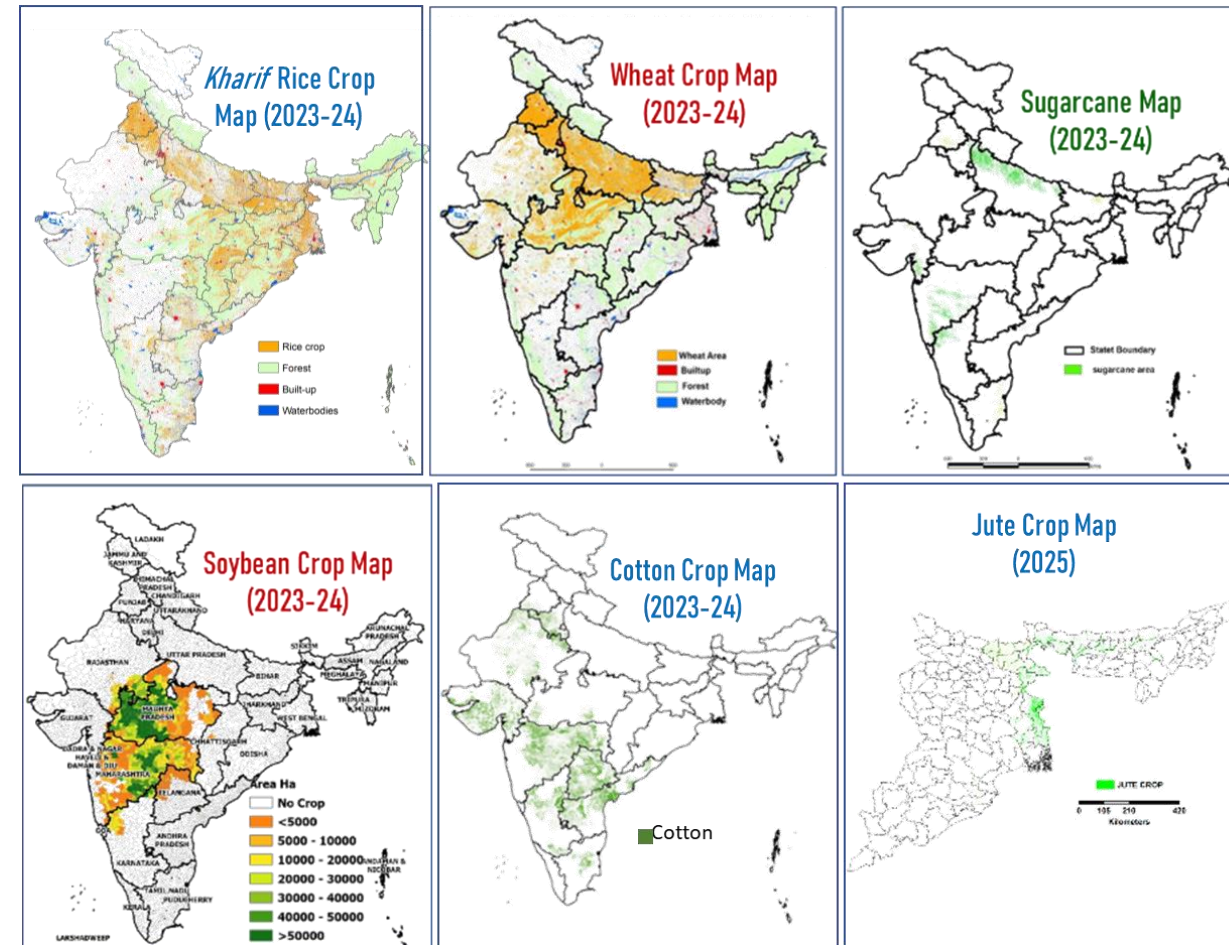
Food Security: Agriculture Crop Mapping

Multiple in-season Crop Acreage and Production Estimation (FASAL)

- Remote sensing based in-season Crop Acreage & Production Estimation (~25 crops)
- Methodology developed by ISRO, **Operationalized by of MNCFC** (9 major Crops: Rice (Kharif & Rabi), Wheat, Rabi Sorghum, Sugarcane, Rapeseed/Mustard, Cotton, Jute, Rabi Pulses)
- Input for Policy decisions on procurement & stock management



National-level Crop Area Mapping of Major Crops

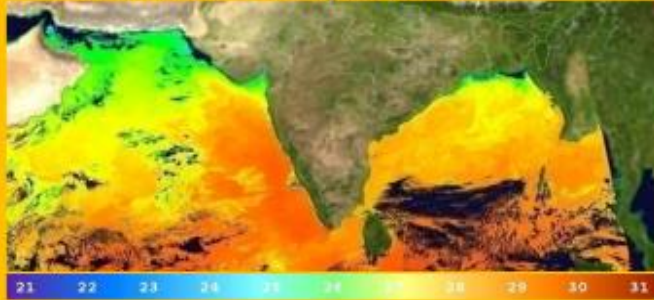


- **Crops:** Rice, Wheat, Cotton, Jute, Sugarcane, Soybean
- Crop condition assessment at regional and national level

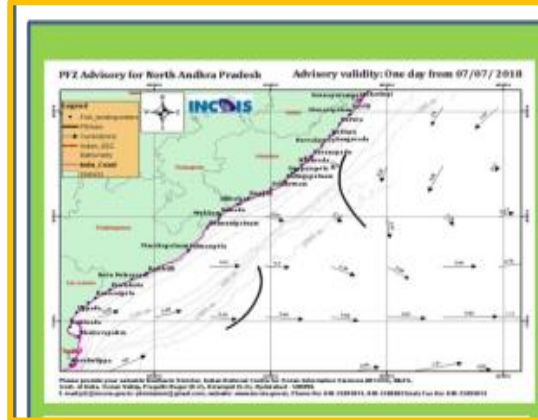
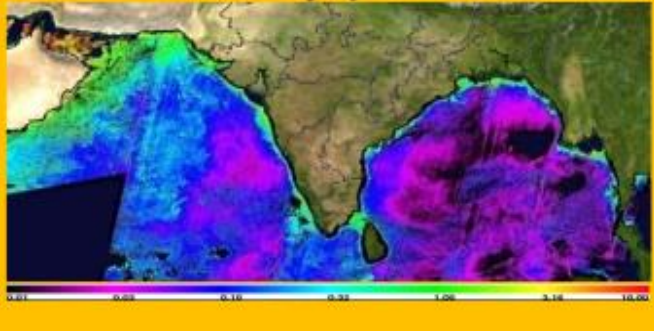
Food Security: Potential Fishing Zone Advisory

Potential Fishing Zone Advisory Services for Fishermen ENHANCED LIVELIHOOD SUPPORT TO FISHERMEN

Sea Surface Temperature



Chlorophyll



National Rollout for Vessel Communication & Support System in Marine Fishing Vessels

1 Lakh MSS terminals through Indian Industry (2025) under PMMSY

- Increased Fish catch per unit effort - by 2-4 times.
- Reduced Search time by 60-70% - saving of fuel
- Improved welfare of community – Better livelihood

- ✓ Improved Potential Fish Catch
- ✓ Navigation Support
- ✓ Rough Weather Alerts
- ✓ Approaching international boundary

Water Security: Sustainable Development of Water Resources

Water Resources

- Irrigation Potential, Expansion, Inter-Basin Water Transport, Water Use Efficiency
- Surface Water -Storage, Dynamics, Quality
- Snow cover , Snowmelt, Reservoir inflows
- Water availability & Demand, Reservoir inflow, Stream flow (Long-term, Future)
- Urban Lakes, Pollution, Water Sources, Spatial Demand

Supporting
CWC, MoJS,
Programmes –
NHP,AIBP,ILR, etc.

Design Projects /Programmes

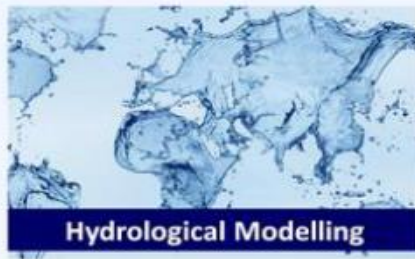
Irrigation Utilisation



Irrigation Expansion



Information Services : Hydrological, Infrastructure, Quantifications



SDG- 2: End hunger, 6: Clean water & sanitation, 11: sustainable cities and Communities, 13: Climate Action

Space Technology Inputs Supporting Governance

Continuous & Demand based inputs for Planning, Monitoring & Evaluation and Decision Support

Support to Government Programmes

PMFBY, MGNREGA, PMKSY (WDC), PMGSY, AMRUT, PMAY,....

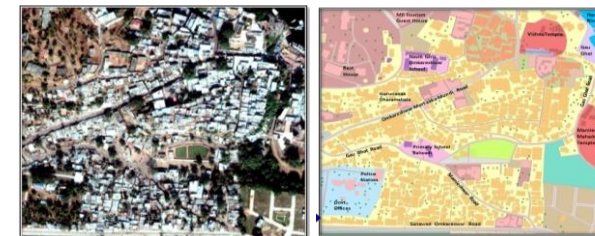
- Technology input for improved Crop Insurance Services – Decision Support
- Food Security Mission – Post-kharif rice fallows for growing pulses
- Watershed management (~86,000 Micro-watersheds) - Assessing the impact of interventions
- Urban transformation – Inputs for Urban Master plans towards Citizen friendly cities
- Monitoring of Public Benefit Schemes (Rural Employment; Housing; etc.) – enhancing efficiency
- De-centralized Governance - Participatory planning at grass-root level
- Connectivity to rural habitations – Rural development
- Water Resources development – for water stressed regions
- National Hydrology Project - Hydroinformatic products



**Food Security Mission-
Suitable areas for short
duration pulses 6 Eastern
States**



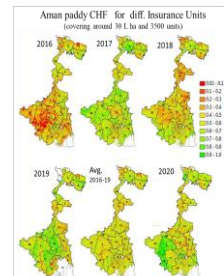
**Monitoring & Evaluation of 86,000
micro-watersheds**



**Urban Geospatial Database for
Master Plan**



Geospatial hydro-products & services



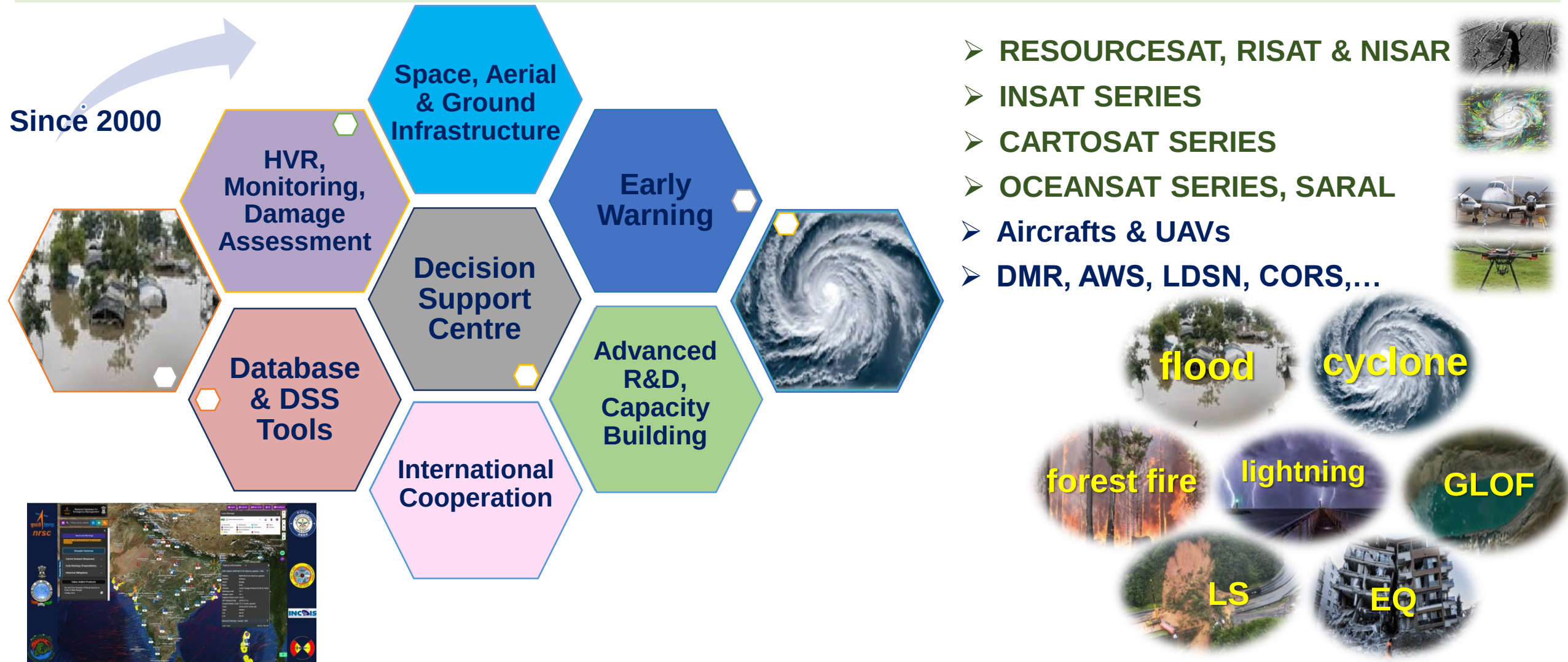
**Crop Health in
Crop Insurance**



**Monitoring Rural
Employment Scheme**

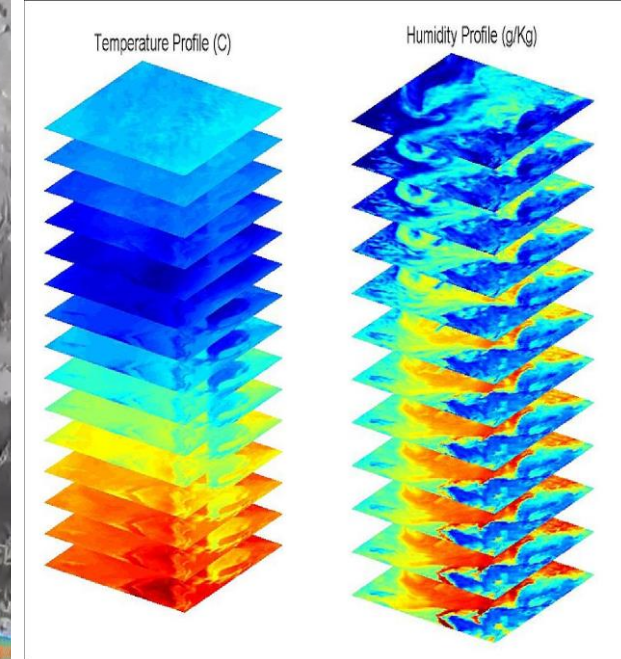
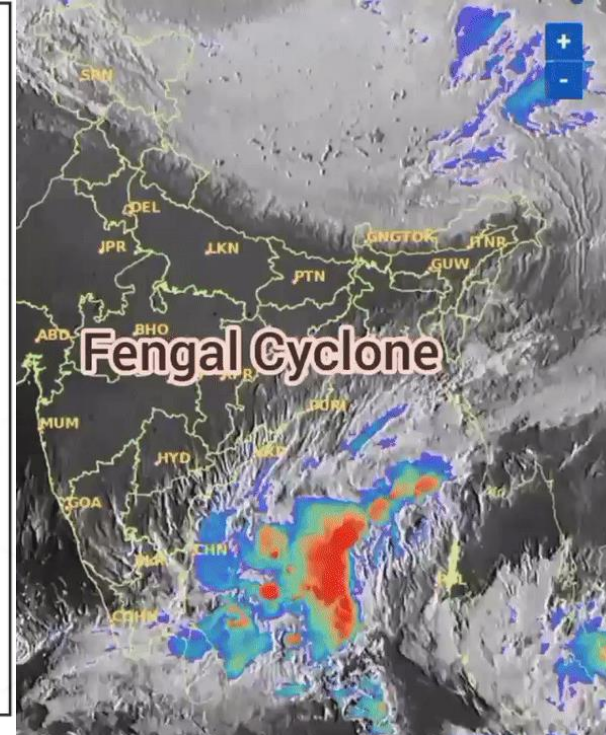
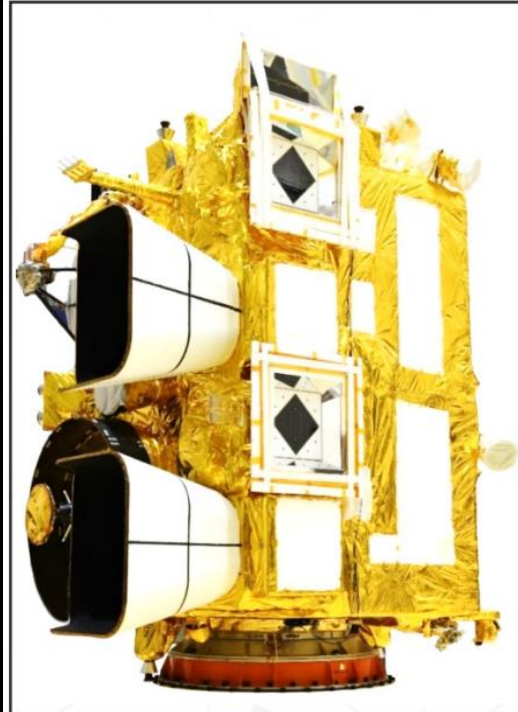
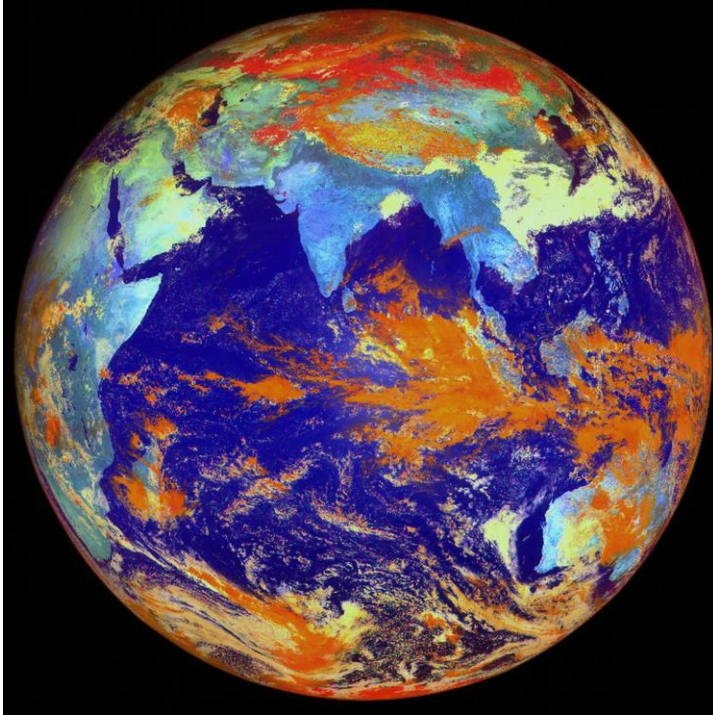
Disaster Management Support Programme of ISRO

Enable space-based inputs for effective disaster management by respective nodal departments/ ministries



Meteorological Applications: INSAT 3D Series

INSAT- 3DR & 3DS imaging in staggered mode

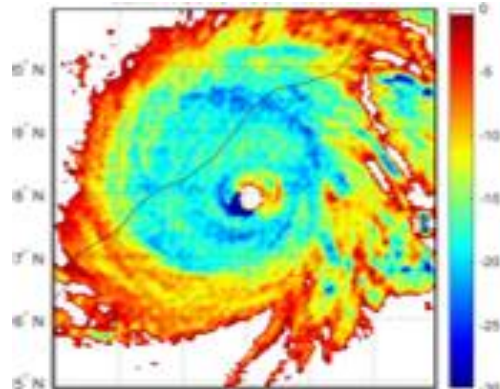


6 Bands Imager

Vis & SWIR: 1 km; MWIR: 4 km; WV: 8 km; TIR(2): 4 km

19 Channel Sounder

48 images per day



30 Geophysical Products at every 15 min interval

Atmospheric Winds

Rainfall

Surf. Temperature

Temperature profile

Snow

Fog

Humidity

Aerosol

A day on the mother earth, as viewed by siblings INSAT-3D and INSAT-3DR



INSAT-3DR/3DS Imager

Ch	Wavelength (μm)	Res. (Km)
1	0.55-0.75	1
2	1.55-1.70	1
3	3.8-4.0	4
4	6.5-7.1	8
5	10.2-11.3	4
6	11.5-12.5	4

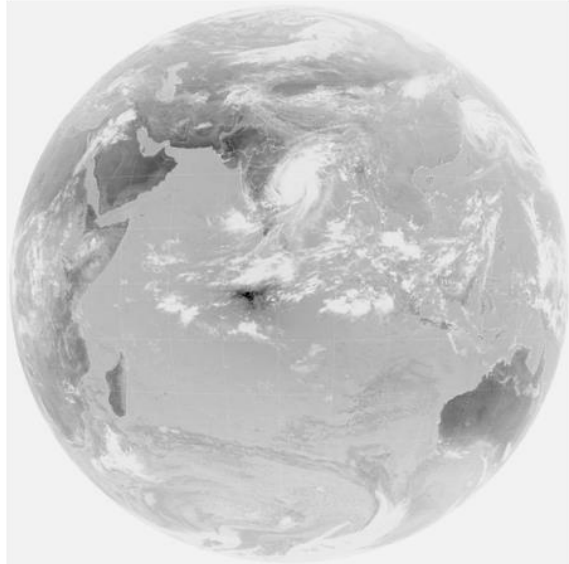
VIS



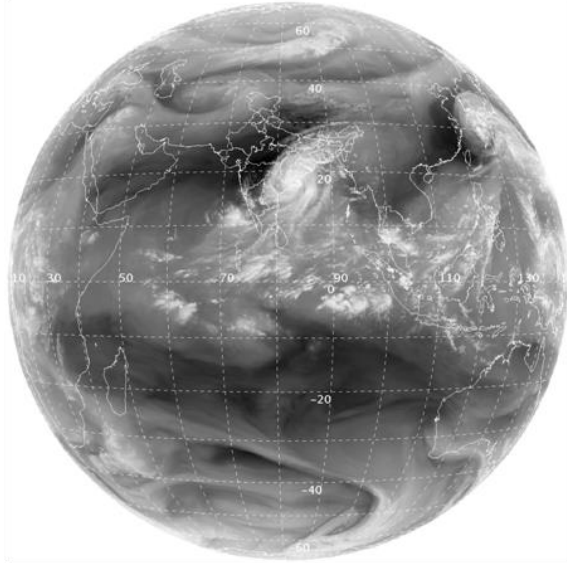
SWIR



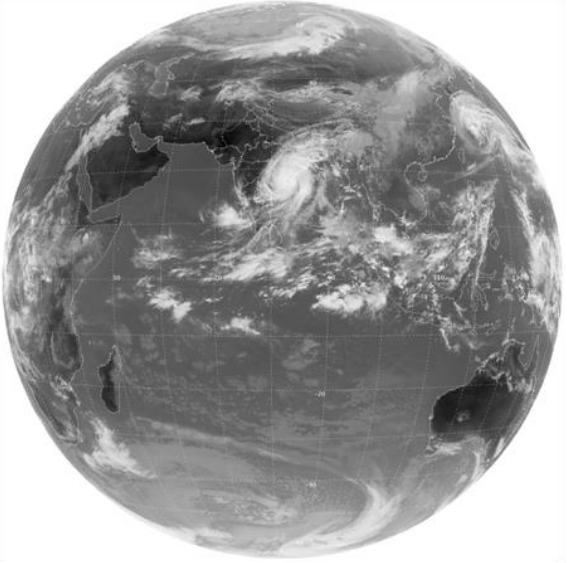
MIR



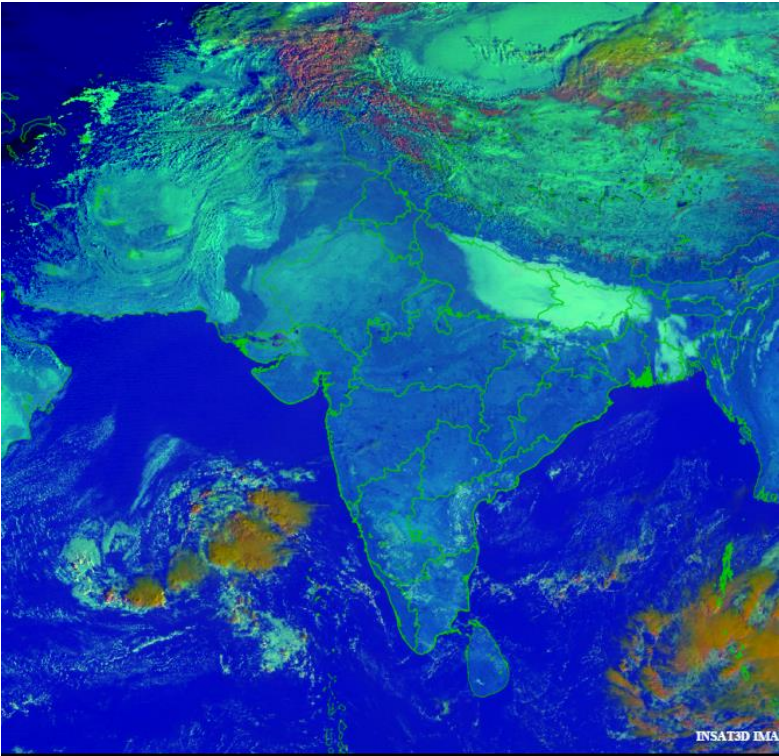
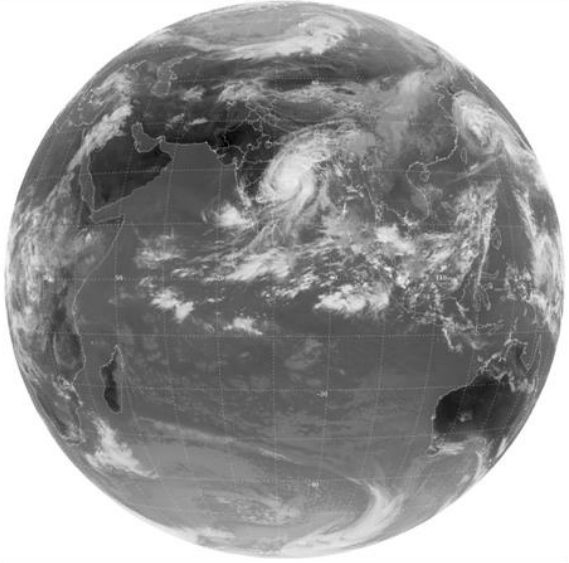
WV



TIR1



TIR2

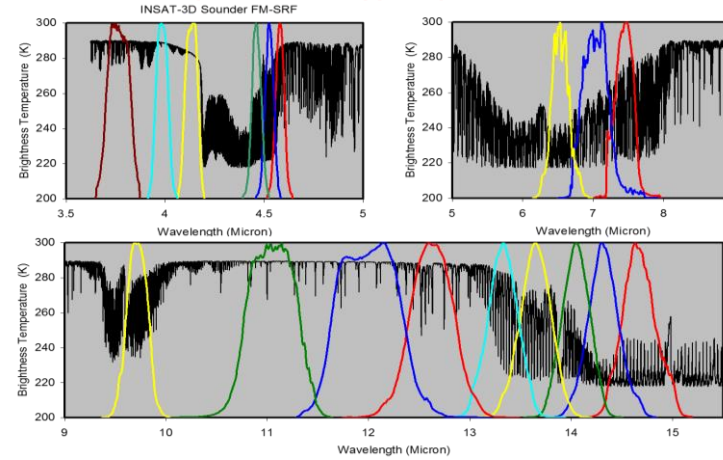


INSAT-3DR/3DS Sounder (2016/2024)

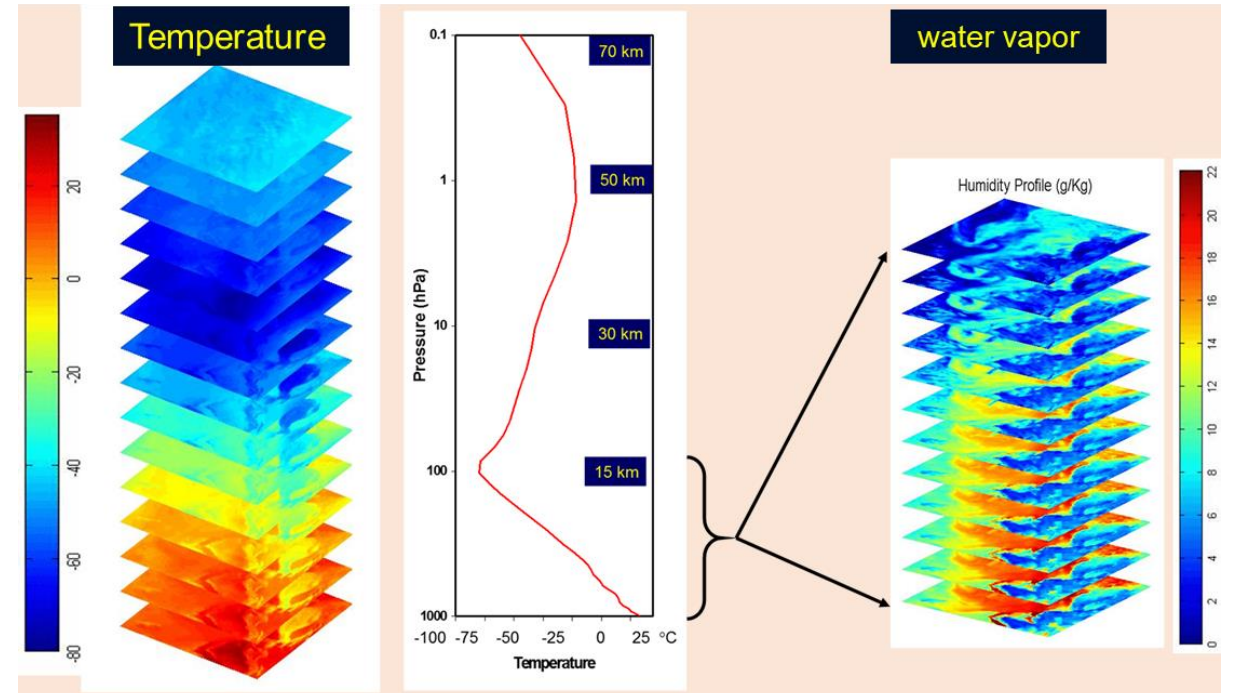
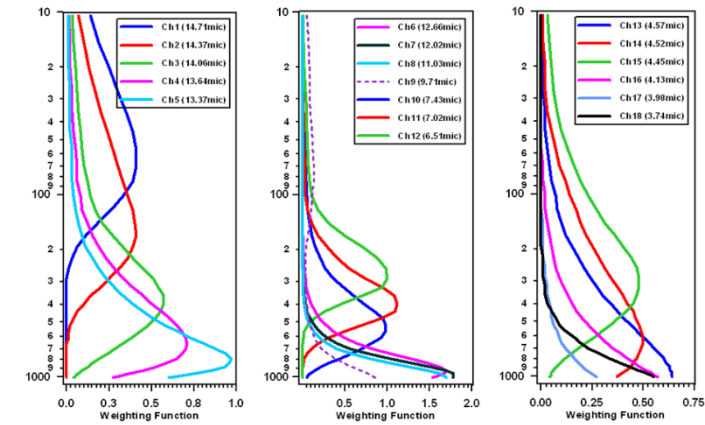
INSAT-3D Sounder Channels Characteristics

Detector	Ch. No.	λ_c (μm)	ν_c (cm^{-1})	NEAT @300K	Principal absorbing gas	Purpose
LWIR	1	14.67	682	0.17	CO ₂	Stratosphere temperature
	2	14.32	699	0.16	CO ₂	Tropopause temperature
	3	14.04	712	0.15	CO ₂	Upper-level temperature
	4	13.64	733	0.12	CO ₂	Mid-level temperature
	5	13.32	751	0.12	CO ₂	Low-level temperature
	6	12.62	793	0.07	water vapor	Total precipitable water
	7	11.99	834	0.05	water vapor	Surface temp., moisture
MWIR	8	11.04	906	0.05	window	Surface temperature
	9	9.72	1029	0.10	ozone	Total ozone
	10	7.44	1344	0.05	water vapor	Low-level moisture
	11	7.03	1422	0.05	water vapor	Mid-level moisture
	12	6.53	1531	0.10	water vapor	Upper-level moisture
SWIR	13	4.58	2184	0.05	N ₂ O	Low-level temperature
	14	4.53	2209	0.05	N ₂ O	Mid-level temperature
	15	4.46	2241	0.05	CO ₂	Upper-level temperature
	16	4.13	2420	0.05	CO ₂	Boundary-level temp.
	17	3.98	2510	0.05	window	Surface temperature
	18	3.76	2658	0.05	window	Surface temp., moisture
Visible	19	0.695	14367	-	visible	Cloud

Launch: 3DR: 08-Sep-2016 (74E)
3DR: 17-Feb-2024 (82E)



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



INSAT-3DR/3DS Operational Geophysical Products (MMDRPS)

Imager

S. No.	Geophysical Parameter	Code
1	Clear Sky Brightness Temperature	CSBT
2	Cloud Mask	CMK
3	Hydro Estimator	HEM
4	Improved IMSRA	IMC
5	Outgoing Longwave Radiation	OLR
6	Sea Surface Temperature	SST
7	Cloud Properties	CTP/CTT
8	Upper Tropospheric Humidity	UTH
9	Land Surface Temperature	LST
10	Total Precipitable Water	TPW
11	Fog	FOG
12	MIR Reflectance	REF
13	Snow	SNW
14	Insolation	INS
15	Land Surface Albedo	LSA
16	Net Effective Radiation	NER
17	Cloud Microphysics	CMP
18	Smoke	SMK
19	Forest Fire	FIR

S. No.	Geophysical Parameter	Code
20	Atmospheric Motion Vectors	IRW, WVW, MRW, VSW
21	Wind Derived Products (WDP)	WDP
22	Merged Wind Products	IRW_MERGED WVW_MERGED
23	High Resolution Winds	VSW_HR
24	Full Disc Winds	IRW_FD, WVW_FD
25	GOES Precipitation Index	GPI
26	Aerosol Optical Depth	AOD
27	Potential EvapoTranspiration	PET_DLY
28	Short Wave Radiation Over Ocean	SWR
29	5 day composite winds	5DCW
30	Actual EvapoTranspiration	AET

Sounder

L1B Product

1. Clear Sky Brightness Temperature (CSBT)

Operational Geophysical Profiles

2. Temperature Profiles
3. WV Profiles
4. Surface Skin Temperature
5. Total Ozone

Derived products

6. Geo Potential Height (at 40 pressure levels)
7. Total Precipitable Water
8. Layer-1 (1000-900 hPa) Precipitable Water
9. Layer-2 (900-700 hPa) Precipitable Water
10. Layer-3 (700-300 hPa) Precipitable Water
11. Lifted Index
12. Wind Index
13. Dry Microburst Index
14. Maximum Vertical Theta-e

Cloud Properties

15. Cloud Top Temperature
16. Cloud Top Pressure
17. Cloud effective Emissivity

Satellite Based Cyclone Monitoring & Prediction

Cyclogenesis
Prediction

Track ,landfall and
intensity Prediction

Cyclone Centric
satellite products

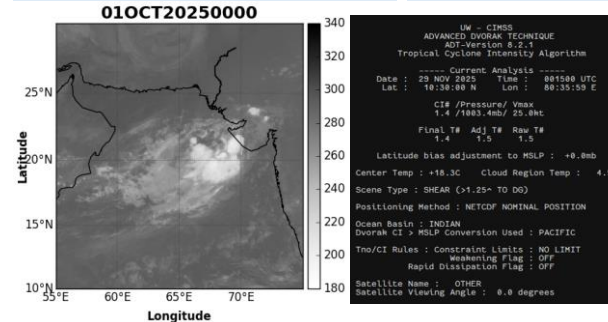
Satellite based
Center, Intensity
Estimation (ADT)

Seasonal Prediction
of NIO cyclones

Changing trends of
NIO cyclones

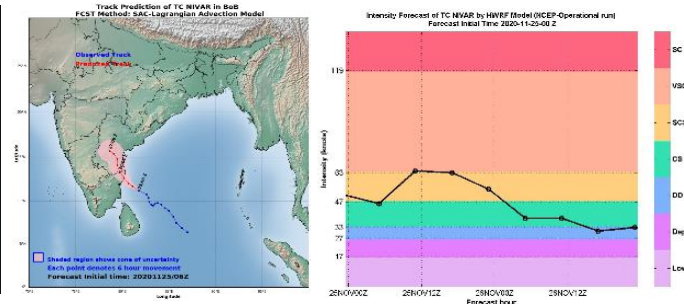
- The cyclones formed in the Bay of Bengal and Arabian Sea are monitored in the near real-time using Indian Satellite data and predicted using in-house developed techniques.
- Synergy of INSAT-3 series and scatterometer are used for low pressure evolution and cyclogenesis prediction.
- INSAT series imager data is used for TC center and ADT based intensity estimation.
- INSAT-3DR Rapid scan data is used to identify TC structural changes during its rapid intensification.
- The scatterometer data is used to correct low level center and estimate wind structure (Rmax, Vmax, Size, wind asymmetry, wind radii).
- The SAR observations are used for TC inner core structure estimation.
- The historical data is used to study the changing trends of NIO TCs (frequency, intensity, translation speed, rainfall etc.) as climate change perspective.
- Seasonal prediction of TCs using global parameters.

Real-time monitoring



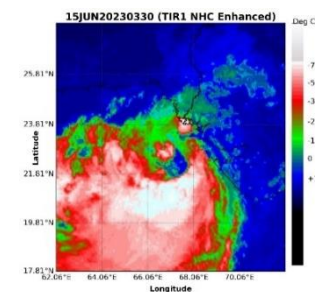
Intensity Estimation

Track and Intensity Prediction

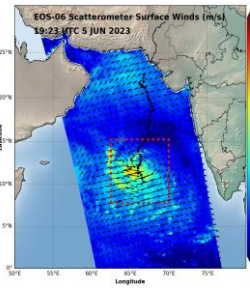


Cyclone centric satellite products

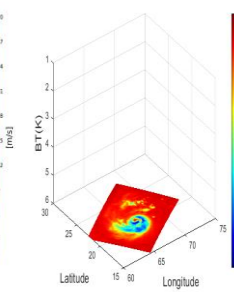
INSAT-3D Imager



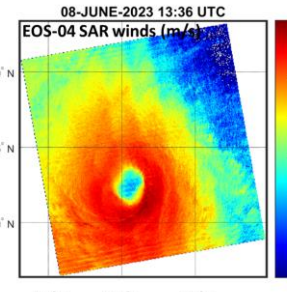
Scatterometer



EOS-07: MHS



EOS-04 SAR



Forecasts are disseminated through: <https://mosdac.gov.in/scorpio/>

Weather Nowcasting Activities

- **Precipitation Nowcasting**

- Nowcasting of INSAT 3DS based HEM Rain Rate

- **DWR Reflectivity Nowcast**

- Optical flow technique based TERLS DWR reflectivity nowcast

- **NWCSAF Products for Nowcast support**

- NWCSAF- GEO application derived products uses meteosat-9 and NWP inputs
- To derive products like Convective Initiation (CI) and Rapid Developing Thunderstorm(RDT)

- **Lightning and Thunderstorm Nowcast**

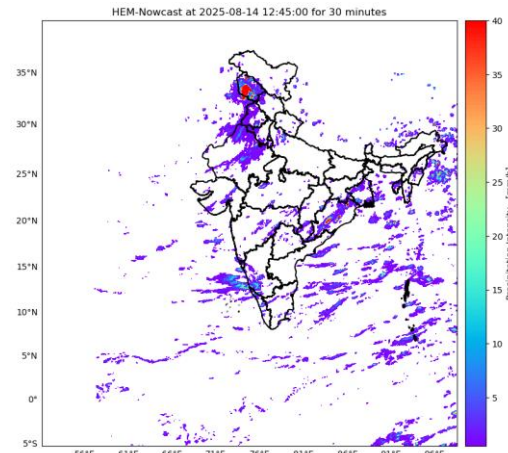
- Lightening Nowcast: using SEVIRI and lightning data and ML based algorithm
- Thunderstorm Phase detection and nowcasting product : Uses INSAT 3DS, NWP and lightning data as inputs,

- **Cloudburst Nowcast**

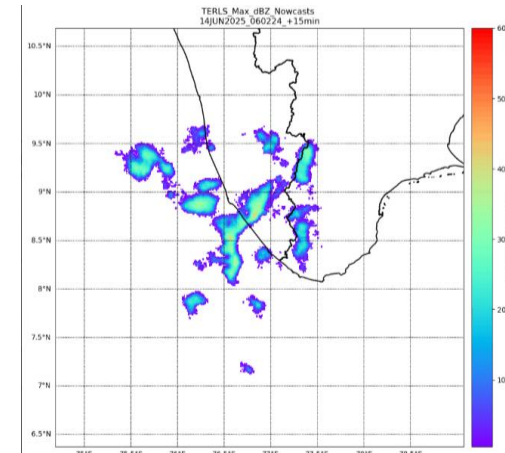
- Based on Cloud top Cooling rate from INSAT 3DS and statistical inputs

- **Cloud Type Nowcast**

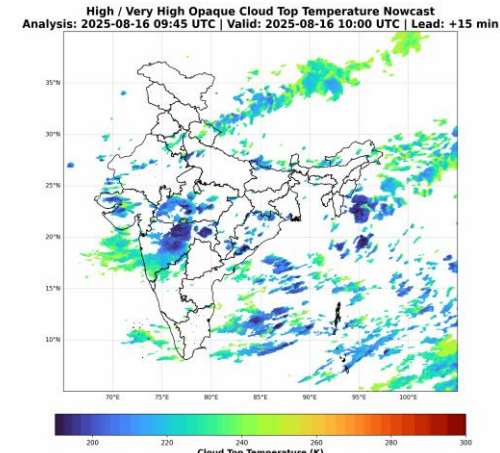
- NWCSAF derived Cloud Type Nowcasting



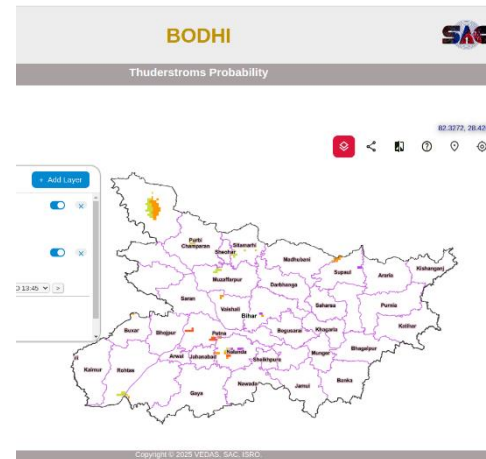
**HEM Rain Rate
Nowcast**



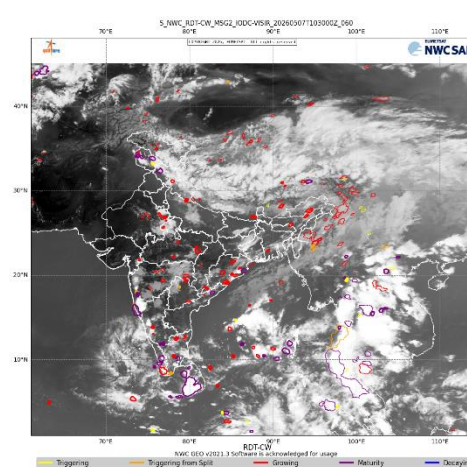
**DWR Reflectivity
Nowcast**



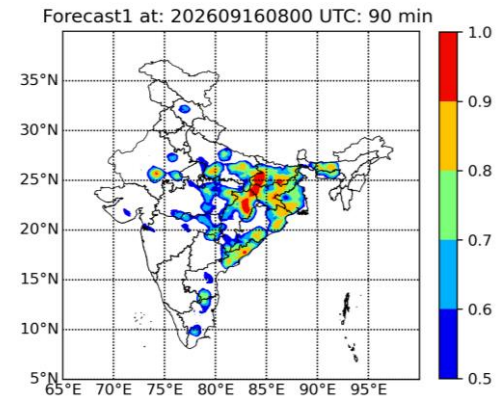
**Cloud Type
Nowcast**



**CI based Sere Weather
Nowcast for BMSK**

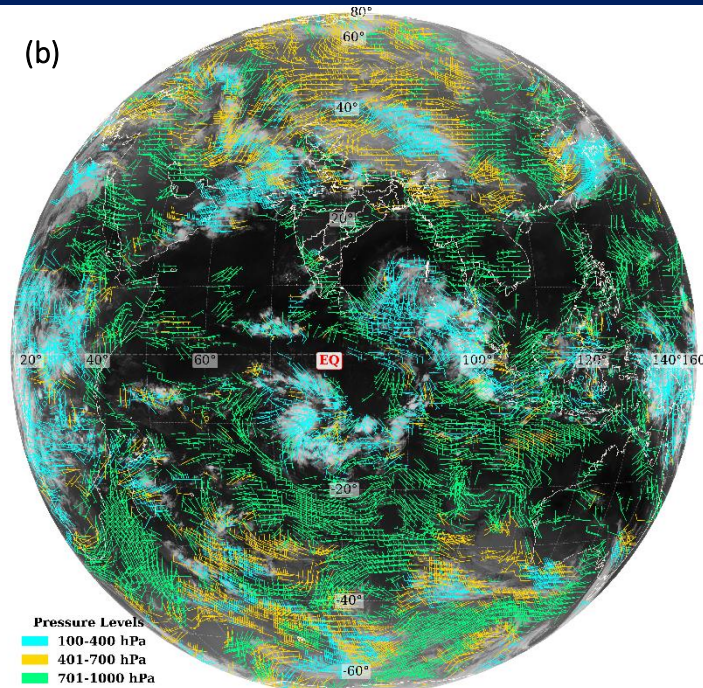
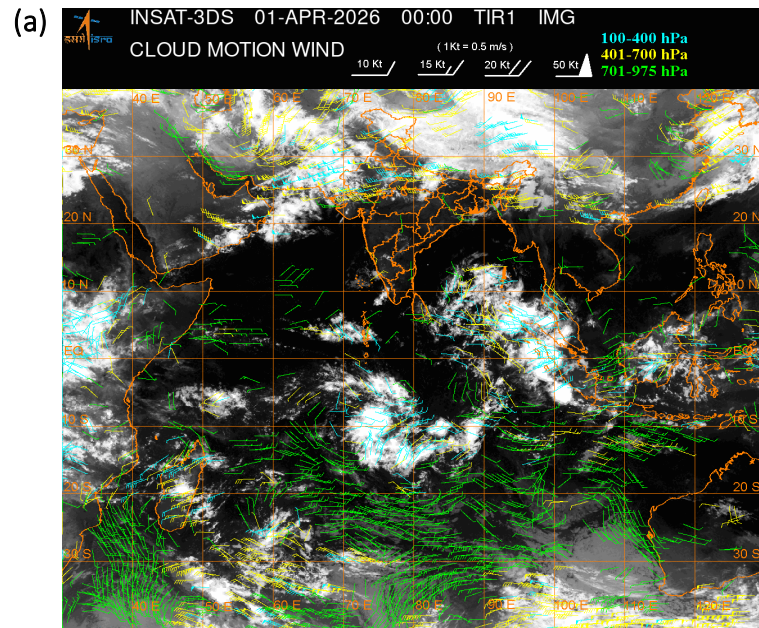


**Rapid Developing
Thunderstorm
Nowcast**



Lightning Nowcast

Retrieved Products: Atmospheric Motion Vector (AMV)

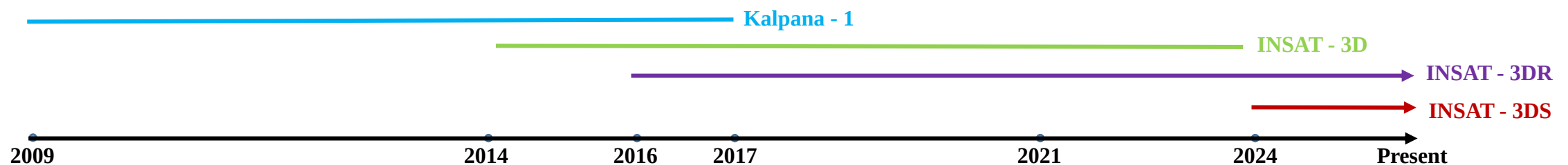


INSAT 3DS Operational AMV Error Statistics (Nov – Jan 2025) wrt ERA5 reanalysis data

Channel	TIR1			WV	VIS	MIR
Parameter	High	Mid	Low	High	Low	Low
MVD	4.50	3.98	2.88	4.58	2.39	2.50
RMSVD	5.34	4.79	3.36	5.42	2.88	3.04
STDV	2.88	2.67	1.73	2.89	1.59	1.72
BIAS	-0.91	-1.58	0.80	-0.56	-0.30	-0.38
Collocations	73059 9	27395 9	93734 0	163139 9	6898 3	48232 7

AMV retrieved from INSAT 3DS TIR 1 channel using (a)SGP (b) Full disk imagery on 01 April 2026 00UTC

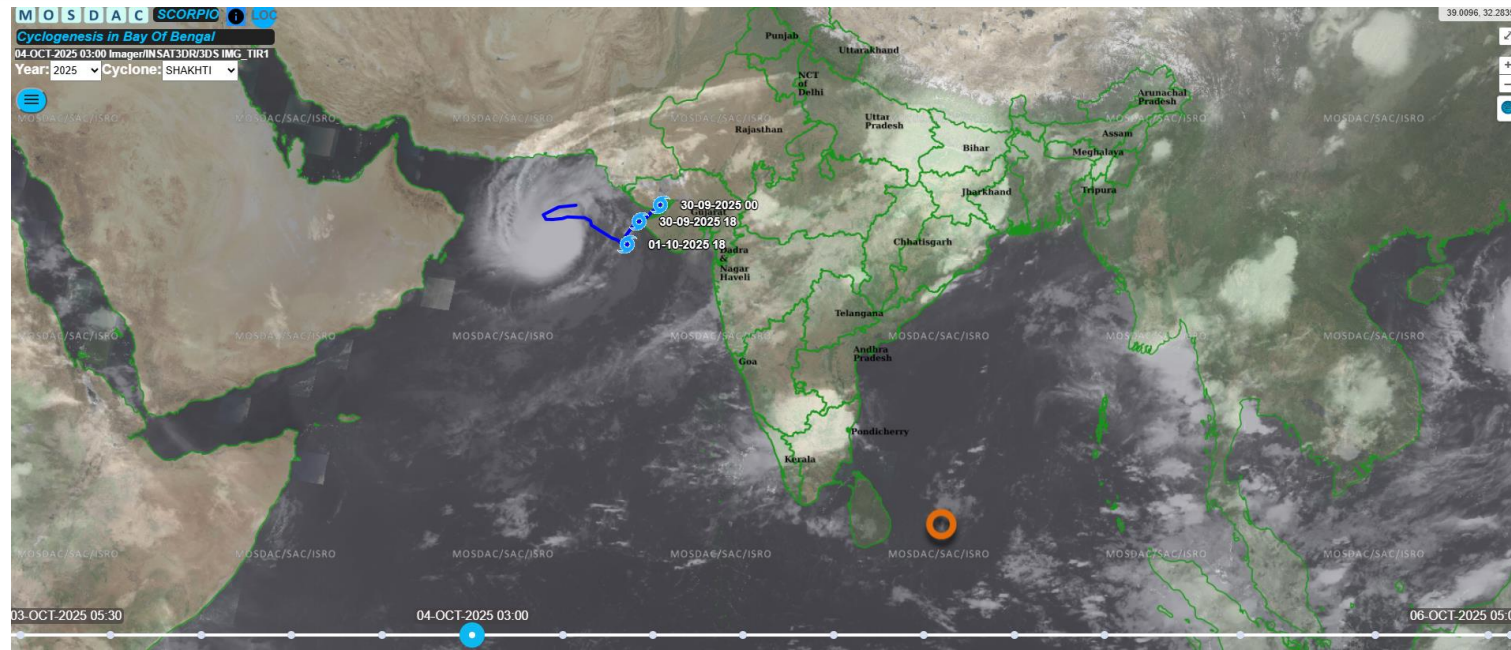
- AMVs are retrieved operationally from INSAT 3DS and INSAT 3DR Sector Generated Product (SGP) imagery using TIR1(10.2 – 11.2 μ m), WV (6.50-7.00 μ m), VIS(0.52 - 0.72 μ m) and MIR(3.8 - 4.00 μ m) channels
- Experiments are ongoing to improve the accuracy of AMVs retrieved from INSAT 3DS full disk imagery, which will be soon operational



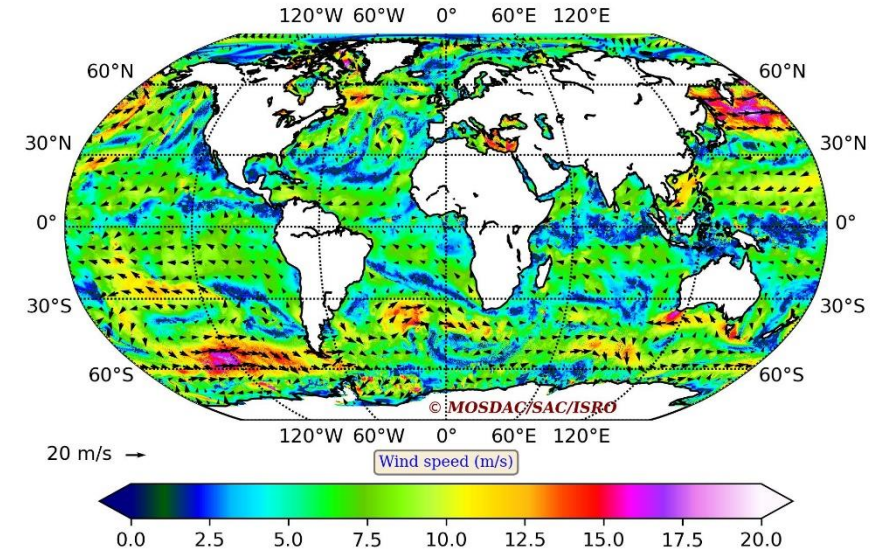
AMV PRODUCT TIMELINE FROM INDIAN GEOSTATIONARY SATELLITES

MOSDAC – Visualization tool

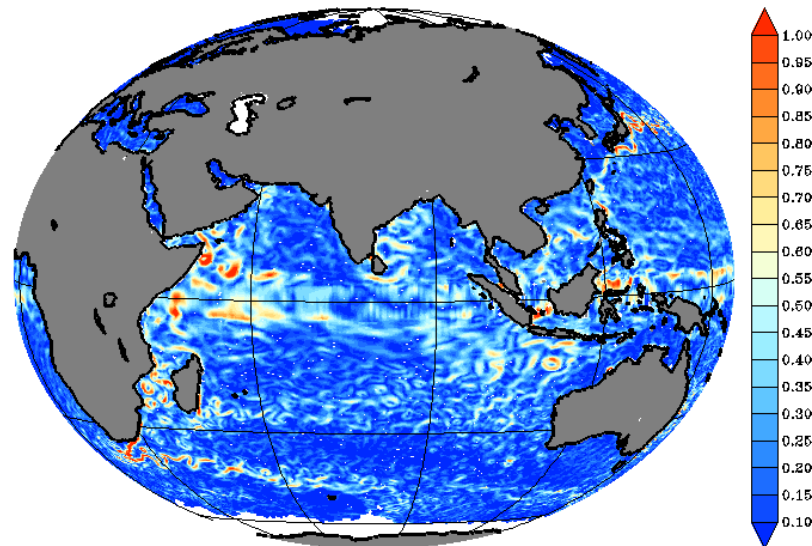
(<https://mosdac.gov.in>)



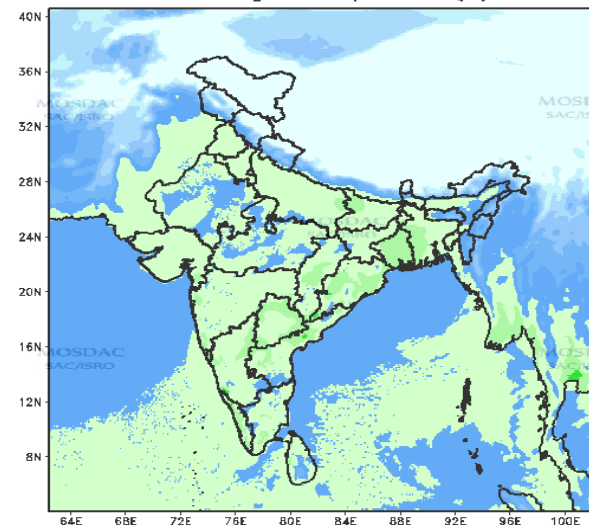
EOS-06 scatterometer Level-4AW Analyzed Wind
Dated: 2023-11-26 12:00:00 GMT



ISRO Ocean Surface Current (m/s) : Indian Ocean on 26NOV2023

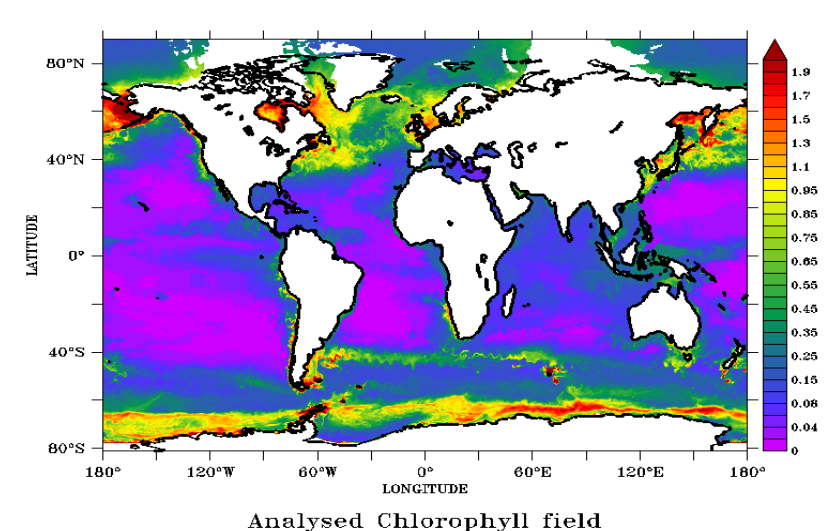


33hr Forecast valid for 1430 IST 29NOV2023
2m height Temperature(C)



Z (level) : 1
TIME : 25-NOV-2023 00:00

DATA SET: Chlorophyll



Actionable products & services through web-portals

- **BHUVAN:** g-Governance, visualization & dissemination of Geospatial information. 1.2PB storage, 25M+ hits/day, 150+ data layers, 270+ Applications, 12 APIs, 230M+ POI
- **MOSDAC:** ISRO's Met & Ocean data products & services' archival & dissemination: 4 PB storage , 13,000 users , 4 lakh products per month. APIs, Jupiter based Interactive Computing,..
- **BHOONIDHI:** 18 Services, 49 satellite missions, ~67000 users, ~16000 user in 2024, 8.0Lakh products download since the launch of geospatial policy
- **NICES:** Multi-institutional initiative for Bio-geophysical parameter retrieval. ECVs: 13; Products: 66.



BHUVAN



BHOONIDHI



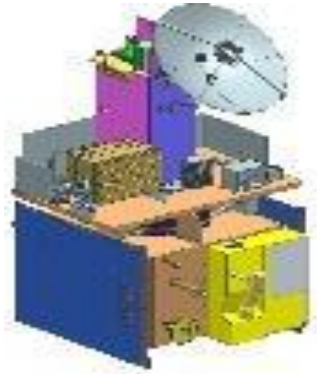
MOSDAC



NICES

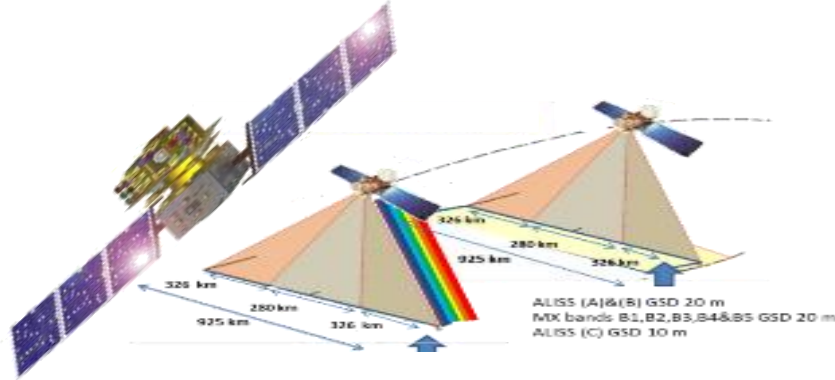
Upcoming Earth Observation Missions

Oceansat-3A



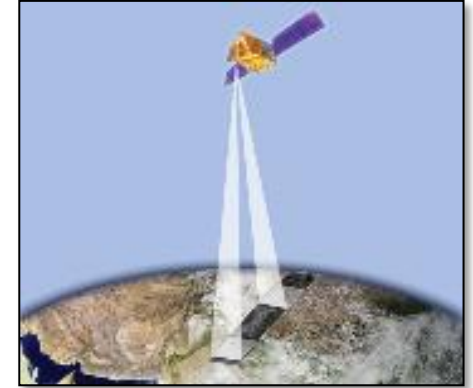
Ocean Color & Wind vector –
Continuity + SST+ MATHS

Resourcesat - 3 & 3A



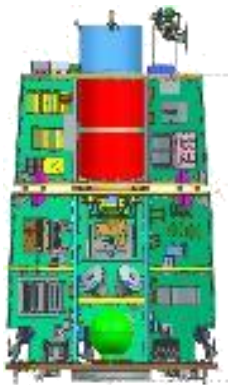
Wide Swath imaging with
improved spatial resolution

Resourcesat - 3S & 3SA



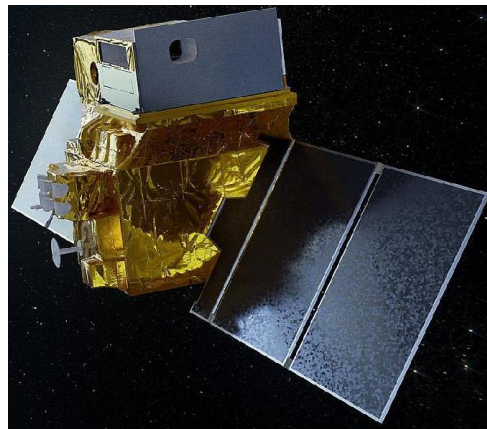
Concurrent Stereo & MX
imaging

HRSAT



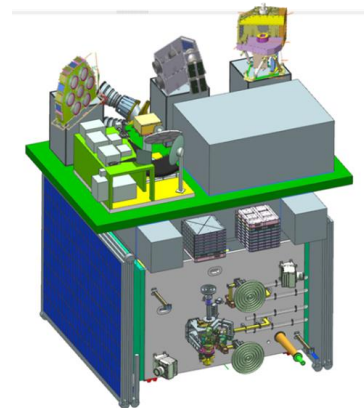
Daily re-visit of
Area of Interest

TRISHNA - High res. TIR & VSNIR



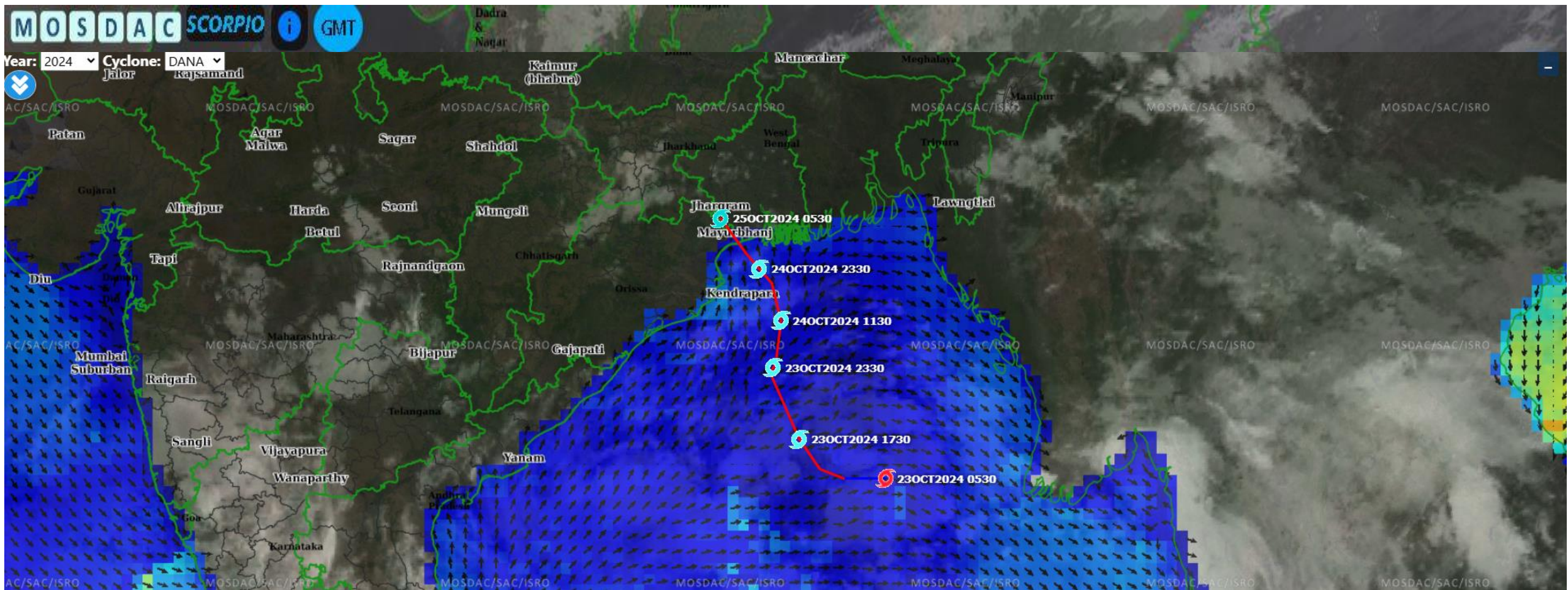
Thermal Imaging

G20 Satellite



Environment & climate change

Thank You



..... Indian Space Programme strives towards maximising the use of Space Technology for the benefit of society

..... and in addressing various national needs on Governance and Development

Thank You

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