Use Of Space Technology In Monitoring Hydrometeorological Hazards

By

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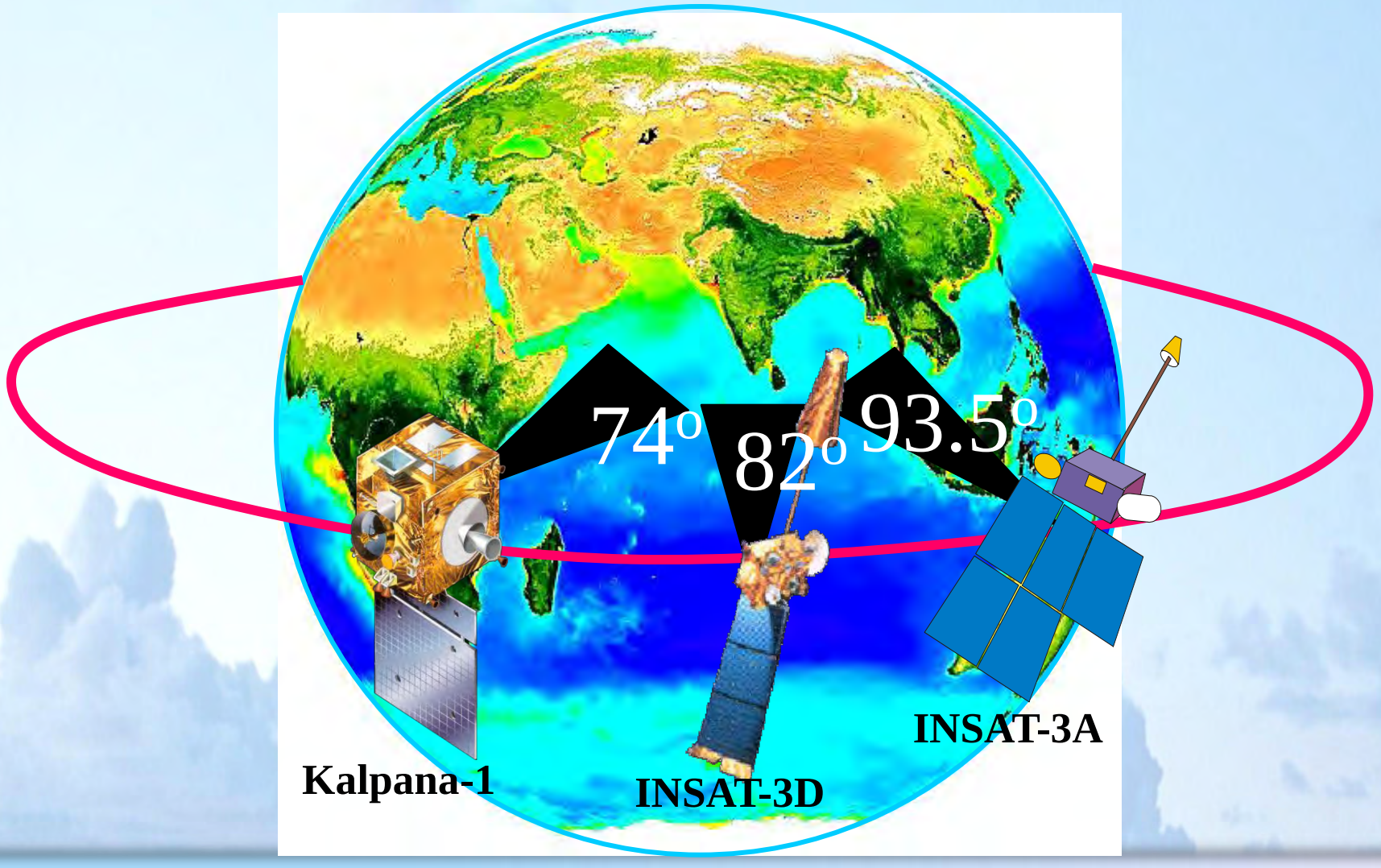
भारत मौसम विज्ञान विभाग

INDIA METEOROLOGICAL DEPARTMENT

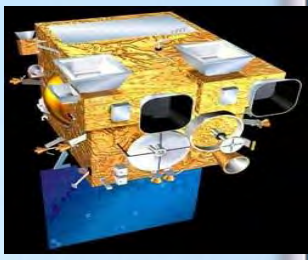

74°
82°
93.5°
Kalpana-1
INSAT-3D
INSAT-3A

Current Indian Geo stationary Meteorological satellites

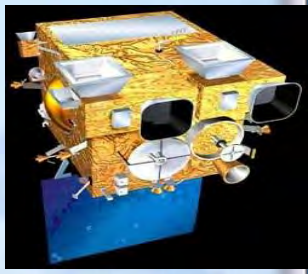
At present the following three INSAT satellites are in operation

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

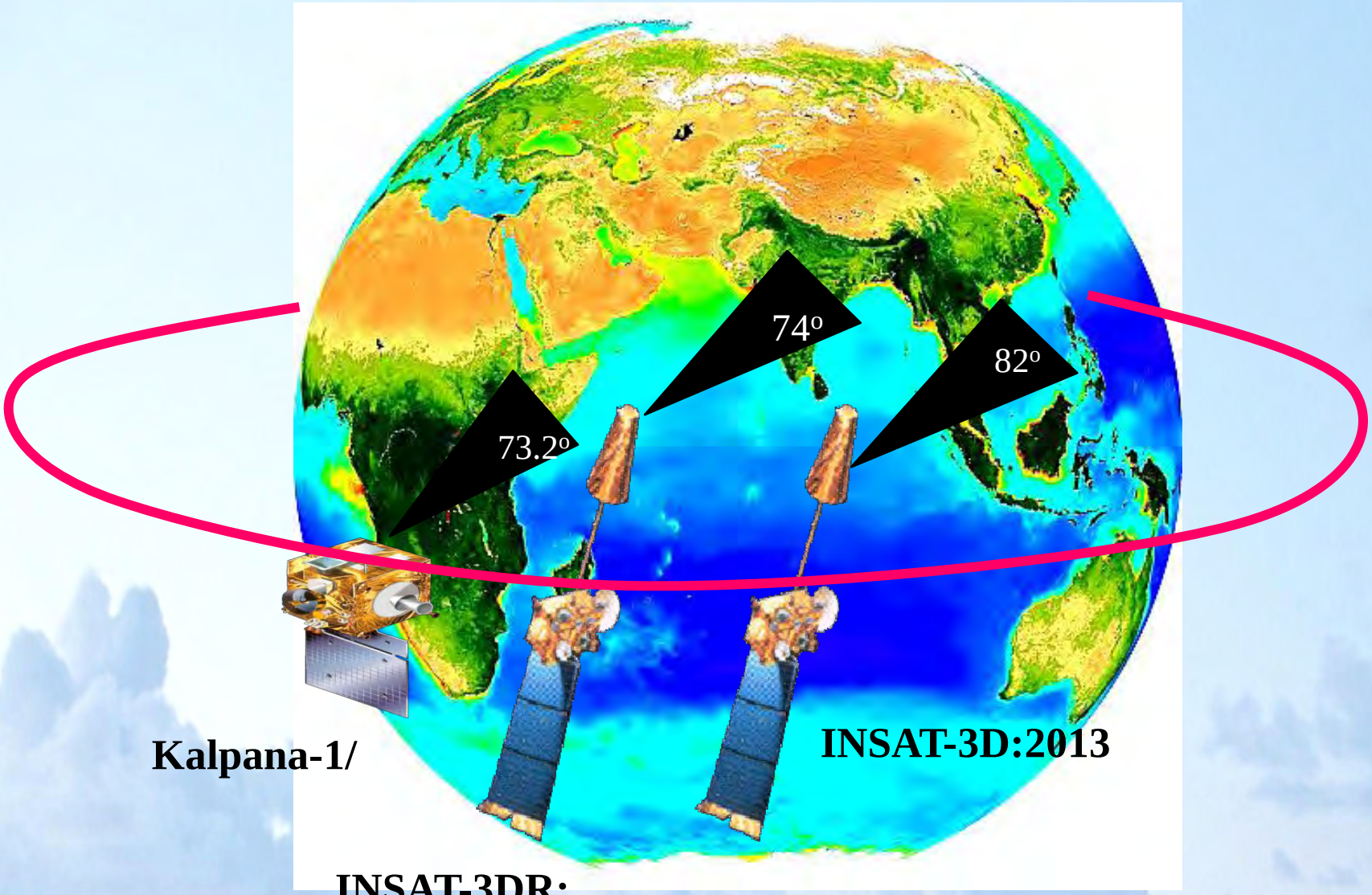
INSAT-3D is a India's advanced weather satellite and was launched in the early hours of July 26, 2013 from Kourou, French Guiana, and has successfully been placed in Geosynchronous orbit. It is a dedicated meteorological satellite and carries four payloads: Imager (Six Channels),Sounder (Nineteen Channels),Data 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.



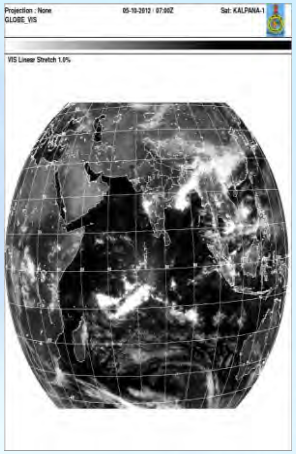
Kalpana-1/

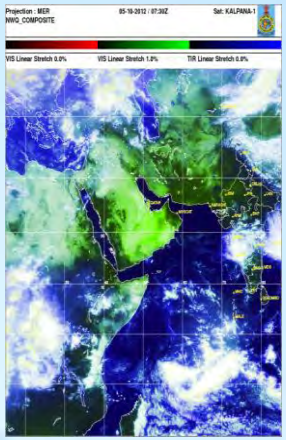
INSAT-3D:2013

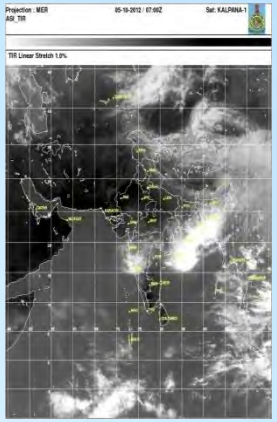
INSAT-3DR:
8th September 2016

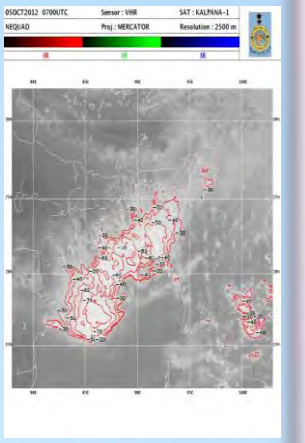
Kalpana-1 Satellite derived imageries

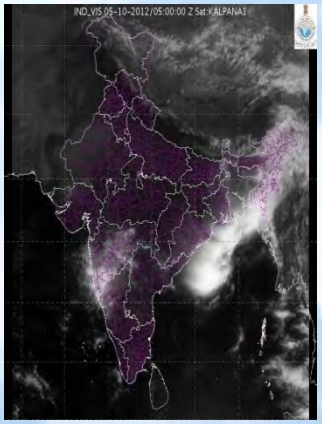
Name of Imageries	K1 VHRR
Full Disc (VIS,IR,WV,Colour composite)	Half hourly
Sectors-Asiamer/NE/NW(VIS,IR,WV,Colour composite)	Half hourly
Enhanced Images(IR,VIS)	Half hourly
Sectors with District boundaires-India/NE/NW/SI(VIS,IR)	Hourly
Average images of IR/WV	Daily
CMV/WVW	Half hourly
CCT,CCTbelow -40deg	Hourly

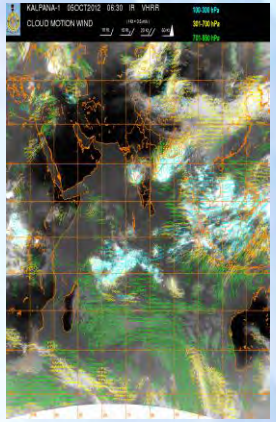


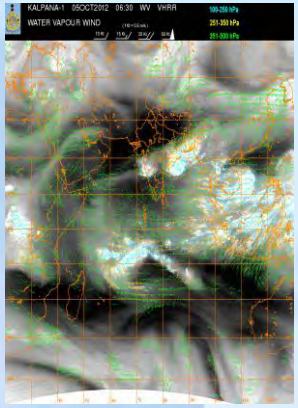












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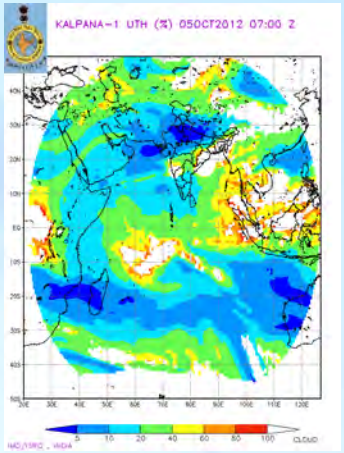
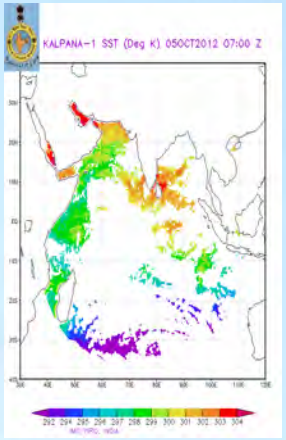
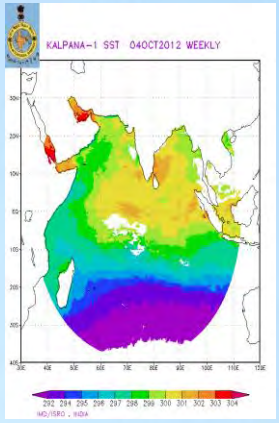
INDIA METEOROLOGICAL DEPARTMENT

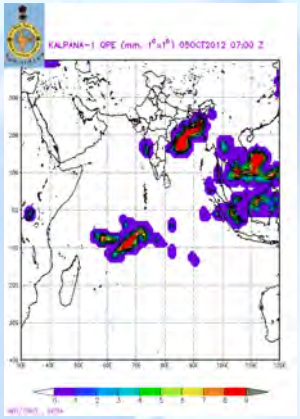
Kalpana-1 Satellite derived products

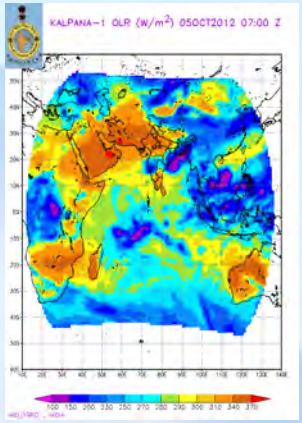
Products	Kalpana-1 VHRR
UTH	Half Hourly, Daily, Weekly and Monthly
SST	Half Hourly, Daily, Weekly and Monthly
OLR	Half Hourly, Daily, Weekly, Monthly and Seasonal
QPE	Half Hourly, Daily, Weekly, Monthly and Seasonal
Latitude/time OLR hovmoeller	Daily
Animated Images for last three Hours	Half hourly
Animated Images with CCT of Current and Previous day based on 06 UTC	Daily

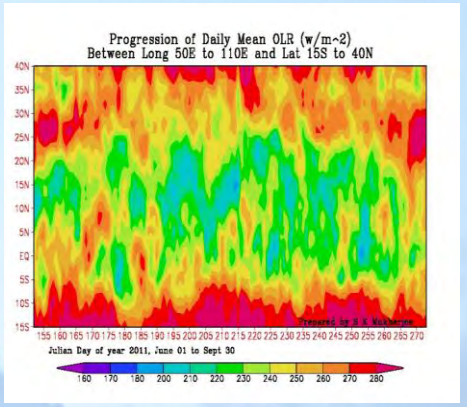




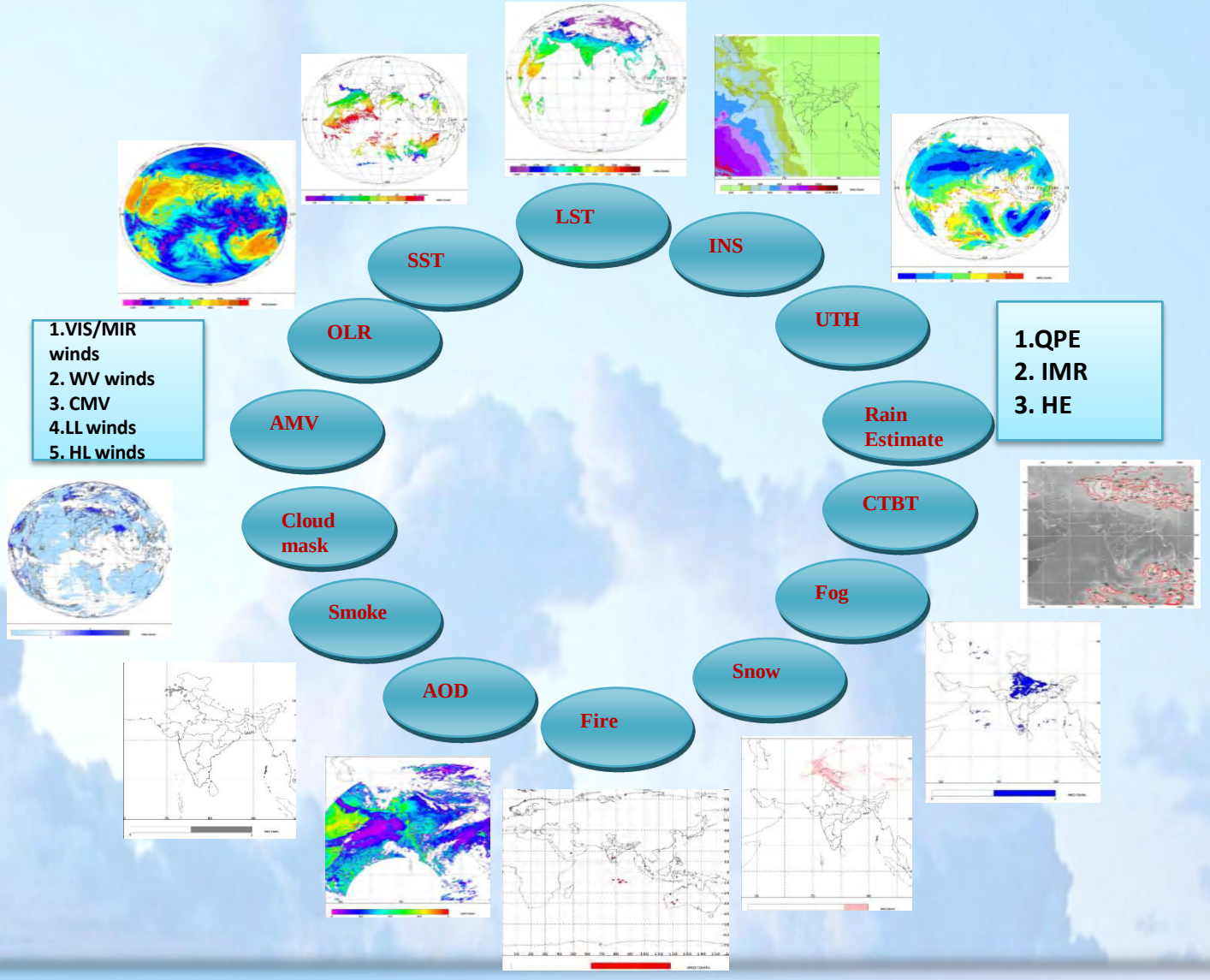




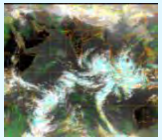


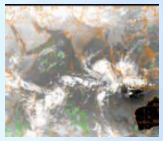


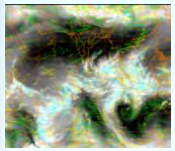
Geophysical parameters/products of INSAT-3D Imager



Geophysical parameters/products of AMV AND Wind Derived Products from INSAT-3D Imager







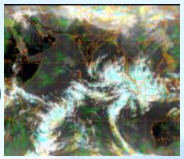
VIS Wind

MIR Wind

CMV

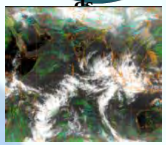
AMV

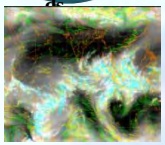
WV Wind

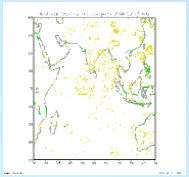


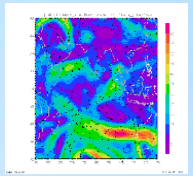
LL Winds

HH Winds



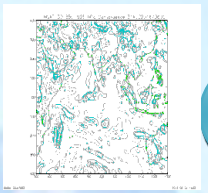






UPPER DIVERGENCE

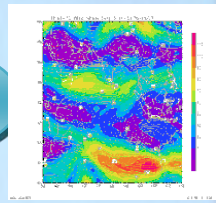
MID LEVEL SHEAR



LOWER CONVERGENCE

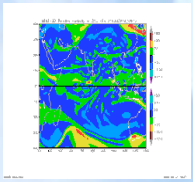
WDP

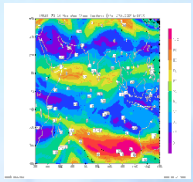
SHEAR



VORTICITY (200, 500, 700,850mb)

SHEAR TEND

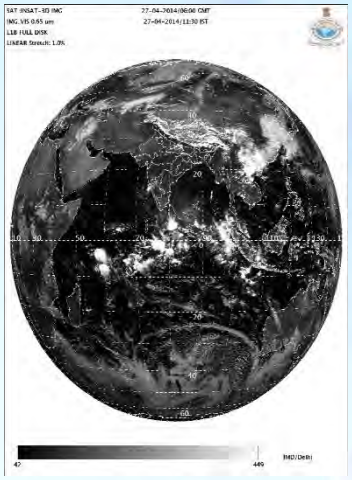




INSAT-3D Imager Channel Specification and their uses

Channels Number	Channel ID	Channel name	Spectral range (µm)	Resolution (Km)	Purpose
1.	VIS	visible	0.55 – 0.75	1.0	Clouds, Surface features
2.	SWIR	short wave infrared	1.55 – 1.70	1.0	Snow, Ice and water phase in clouds
3.	MIR	medium wave infrared	3.7 – 3.9	4.0	Clouds, Fog, Fire
4.	WV	water vapour	6.5 – 7.1	8.0	Upper-Troposphere Moisture
5.	TIR1	long wave infrared	10.3 – 11.3	4.0	Cloud top and surface temperature
6.	TIR2	split	11.5 - 12.5	4.0	Lower-Troposphere Moisture

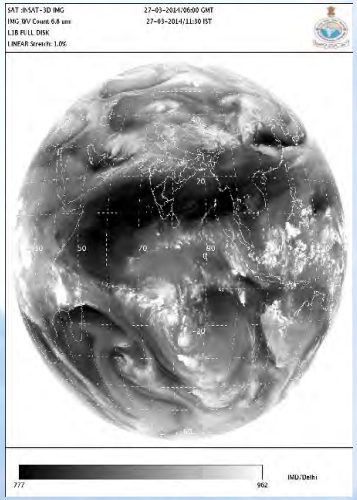
INSAT-3D Imager
Standard Products (L1B)



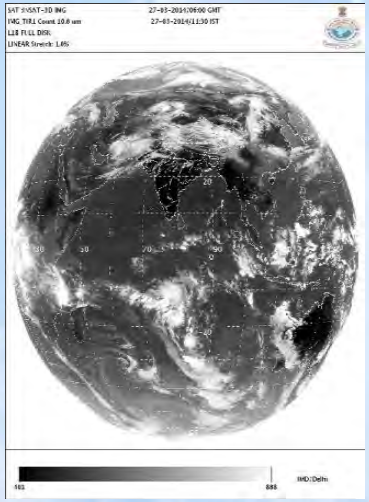
VIS (0.55-0.75µm)

SWIR(1.55-1.70µm)

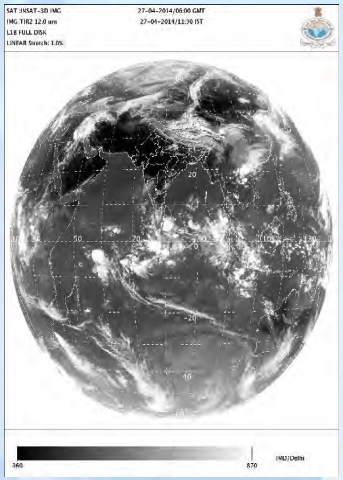
MIR(3.80-4.00µm)



WV(6.50-7.10µm)

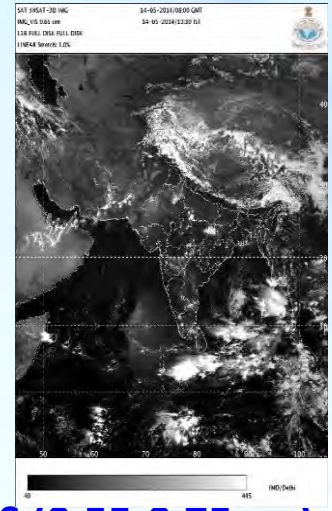


ITR-1(10.30-11.30µm)

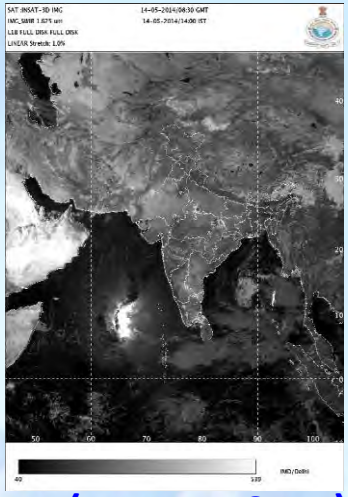


T1IR-2(1.50-12.50µm)

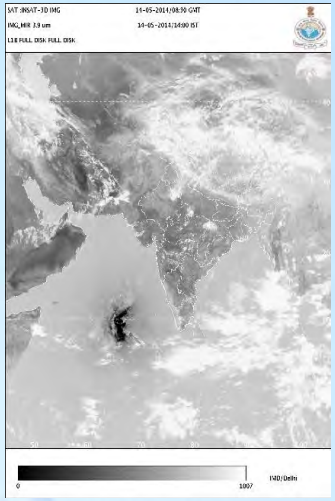
INSAT-3D Imager
Sector Products (L1C)



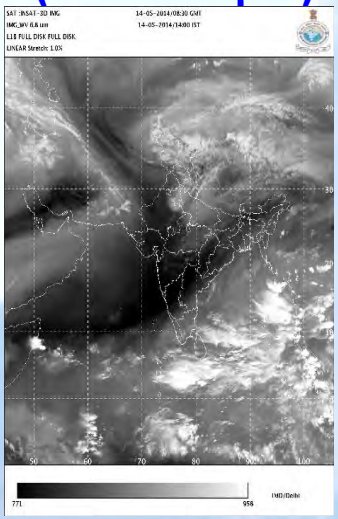
VIS (0.55-0.75µm)



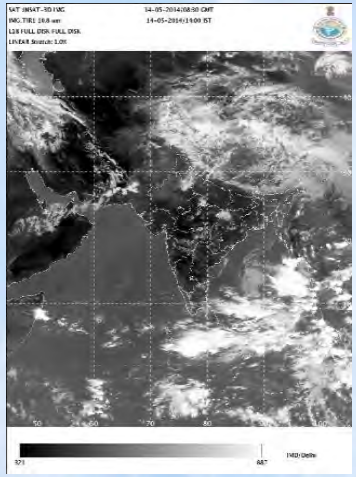
SWIR(1.55-1.70µm)



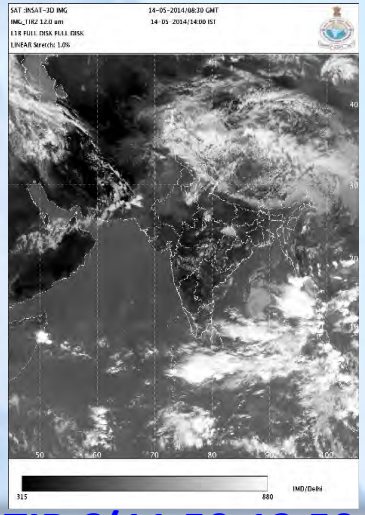
MIR(3.80-4.00µm)



WV(6.50-7.10µm)

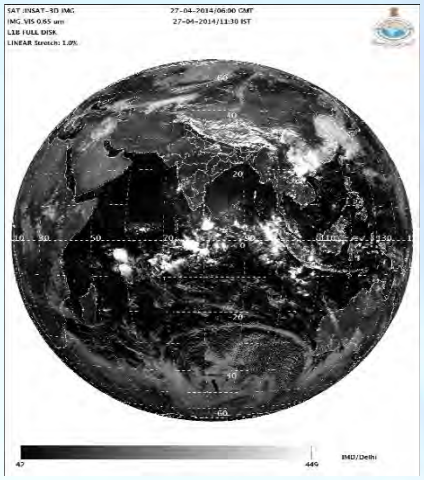


TIR-1(10.30-11.30µm)



TIR-2(11.50-12.50µm)

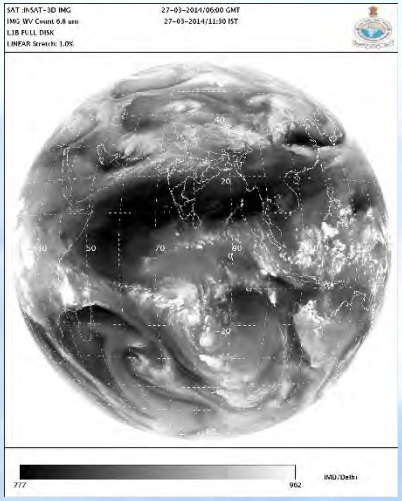
INSAT-3D Imager
Standard Products (L1B) viewed on 27 APR 2014 at 0600 UTC



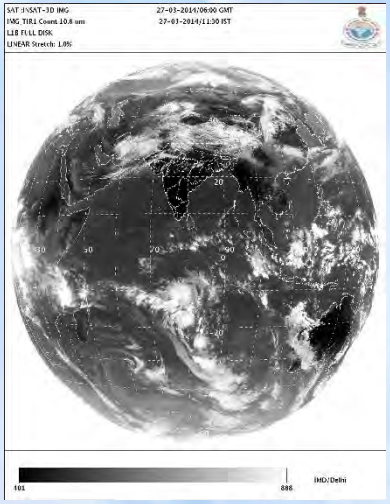
VIS (0.55-0.75µm)

SWIR(1.55-1.70µm)

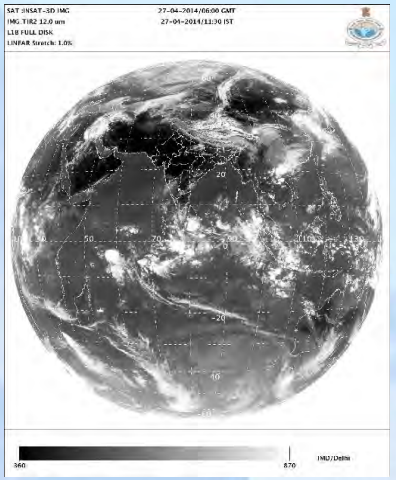
MIR(3.80-4.00µm)



WV(6.50-7.10µm)



TIR-1(10.30-11.30µm)



TIR-2(11.50-12.50µm)

No.	Parameters	Input Channels	No.	Parameters	Input Channels
1.	Outgoing Long wave Radiation (OLR)	TIR -1, TIR -2, WV	10.	Water Vapor Wind (WVW)	WV, TIR -1, TIR -2
2.	Quantitative Precipitation Estimation (QPE)	TIR -1, TIR -2, WV	11.	Upper Tropospheric Humidity (UTH)	WV, TIR -1, TIR -2
3.	Sea Surface Temperature (SST)	SWIR,TIR -1, TIR -2, MIR	12.	Temperature, Humidity profile & Total ozone	Sounder all channels
4.	Snow Cover	VIS, SWIR, TIR -1, TIR -2	13.	Value added parameters from sounder products	Sounder products
5.	Snow Depth	VIS, SWIR, TIR -1, TIR -2	14.	FOG	SWIR, MIR , TIR -1, TIR -2
6.	Fire	MIR, TIR -1	15.	Normalized Difference Vegetation Index	CCD
7.	Smoke	VIS, TIR -1, TIR -2, MIR	16.	Flash Flood Analyzer	TIR -1, TIR -2, VIS
8.	Aerosol	VIS, TIR -1, TIR -2	17.	HSCAS	VIS
9.	Cloud Motion Vector (CMV)	VIS, TIR -1, TIR -2	18.	Tropical Cyclone-intensity /position	AODT technique,TIR-

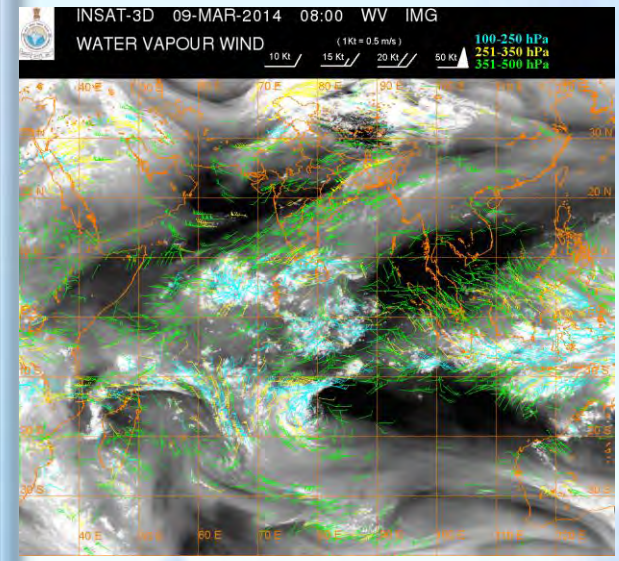
INSAT-3D Imager Products types and formats

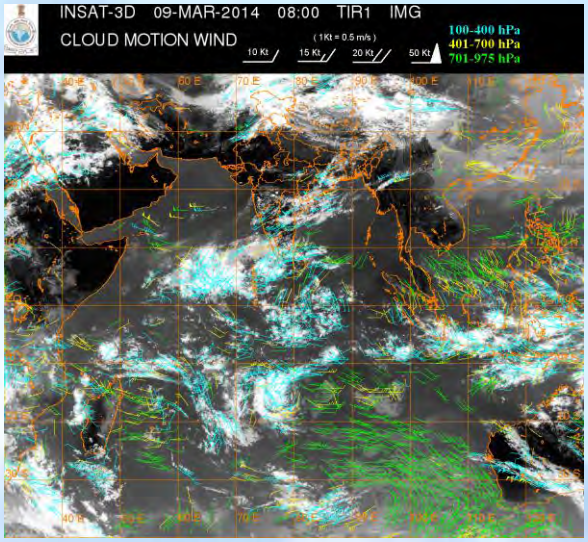
Geo-Physical Parameters						
1	Outgoing long wave radiations	L2B/L3B	OLR	HDF	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly)	WV, TIR-1, TIR -2
2	Rainfall using Hydro Estimator	L2B/L3B	HEM	HDF	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly)	TIR-1, TIR- 2
3	FOG	L2C/L3C	FOG	HDF	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly)	SWIR, MIR, TIR-1, TIR-2
4	SNOW	L2C/L3C	SNW	HDF	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly)	VIS, SWIR, TIR – 1, TIR –2
5	Cloud Mask	L2B/L3B	CMK	HDF	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly)	MIR, TIR-1, TIR-2
6	Upper Troposphere Humidity	L2B/L3B	UTH	HDF	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly)	WV, TIR-1, TIR –2
7	Sea Surface Temperature	L2B/L3B	SST	HDF	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly)	MIR,TIR -1,TIR -2
8	Land Surface Temperature	L2B/L3B	LST	HDF	Per Pixel(Half hourly ,Daily, Weekly & Monthly)	TIR -1,TIR -2
9	INSOLATION	L2B/L3B	INS	HDF	Per Pixel(Half hourly ,Daily, Weekly, Monthly and Yearly)	TIR -1,TIR -2

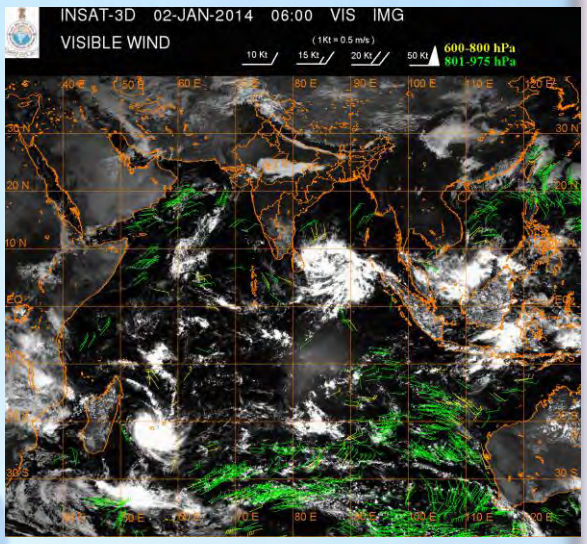
INSAT-3D Imager Products types and formats

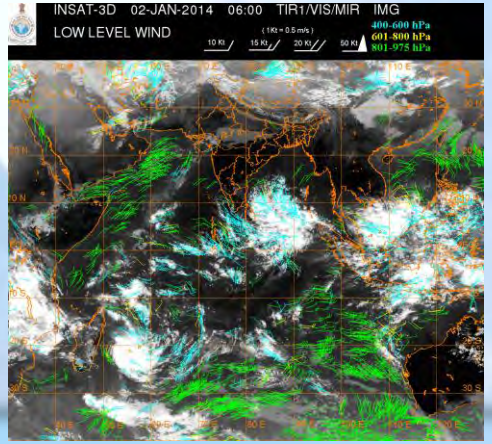
Geo-Physical Parameters (Point)						
1	FIRE	L2P	FIR	KML	Point	MIR , TIR -1
2	SMOKE	L2P	SMK	KML	Point	VIS, MIR, TIR 1, TIR –2
3	Atmospheric Motion Vectors(VIS/MIR, TIR, WV)	L2P	AMV	HDF	(Point)	VIS, TIR-1, TIR –2 & WV
Geo-Physical Parameters (Gridded)						
1	INSAT Multi-Spectral Rainfall Algorithm (IMSRA)	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

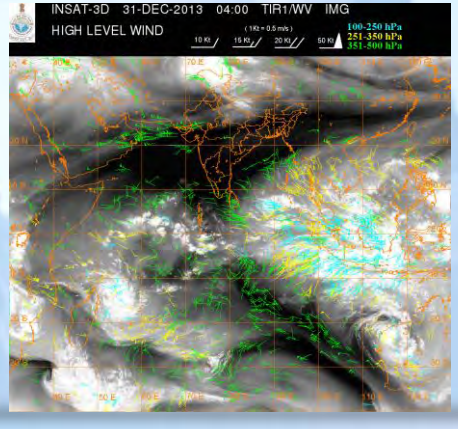
INSAT-3D Wind Products: Visible/MIR,CMV,WVW,LLW &HLW as viewed on 2 January 2014 at 600UTC



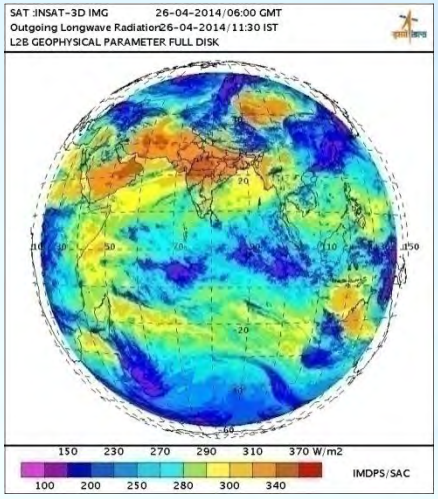




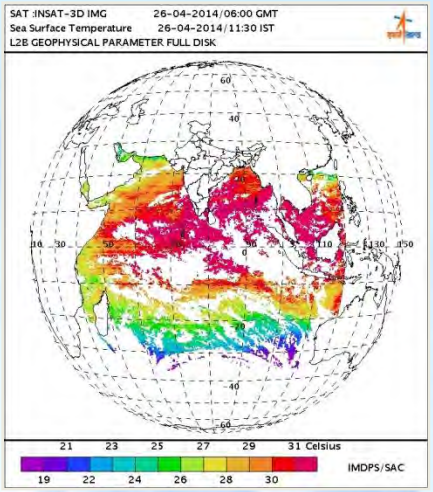




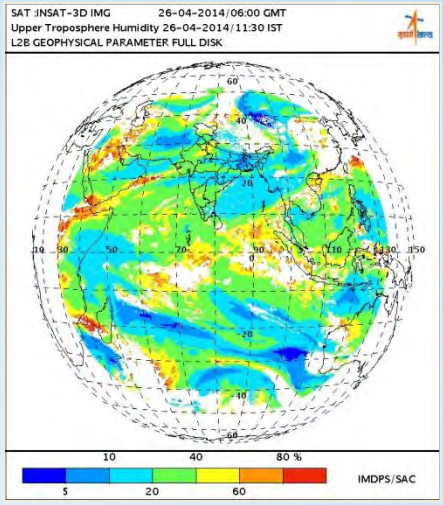
INSAT-3D Imager
Geo-Physical Parameters (L2) viewed on 27 APR 2014 at 0600



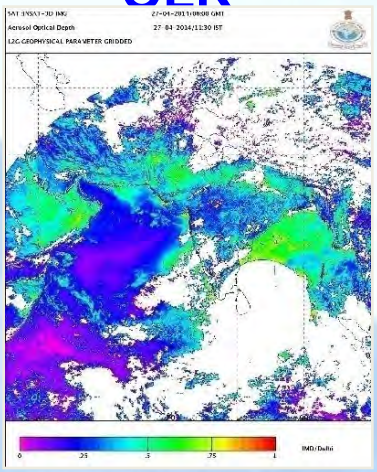
OLR



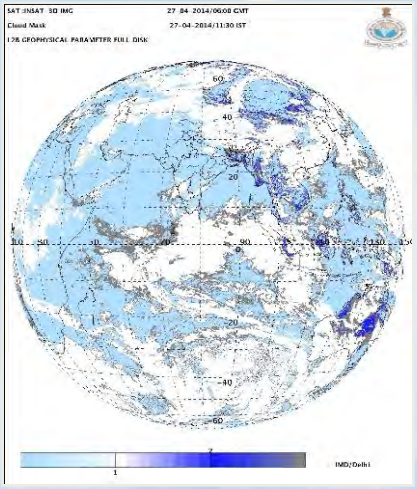
SST



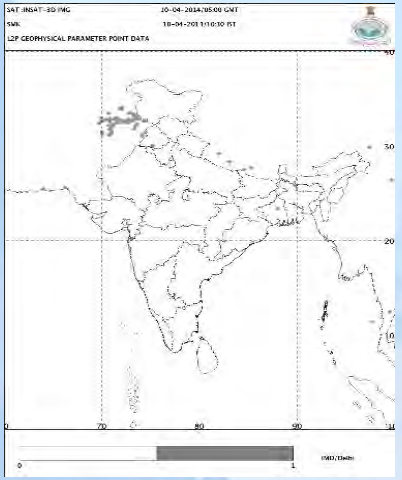
UTH



AOD



CMK



Smoke

भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT

Monitoring of Different Weather Systems

Monitoring of Tropical Cyclone

- Satellite imagery is helpful to find out the Centre and intensity of the system

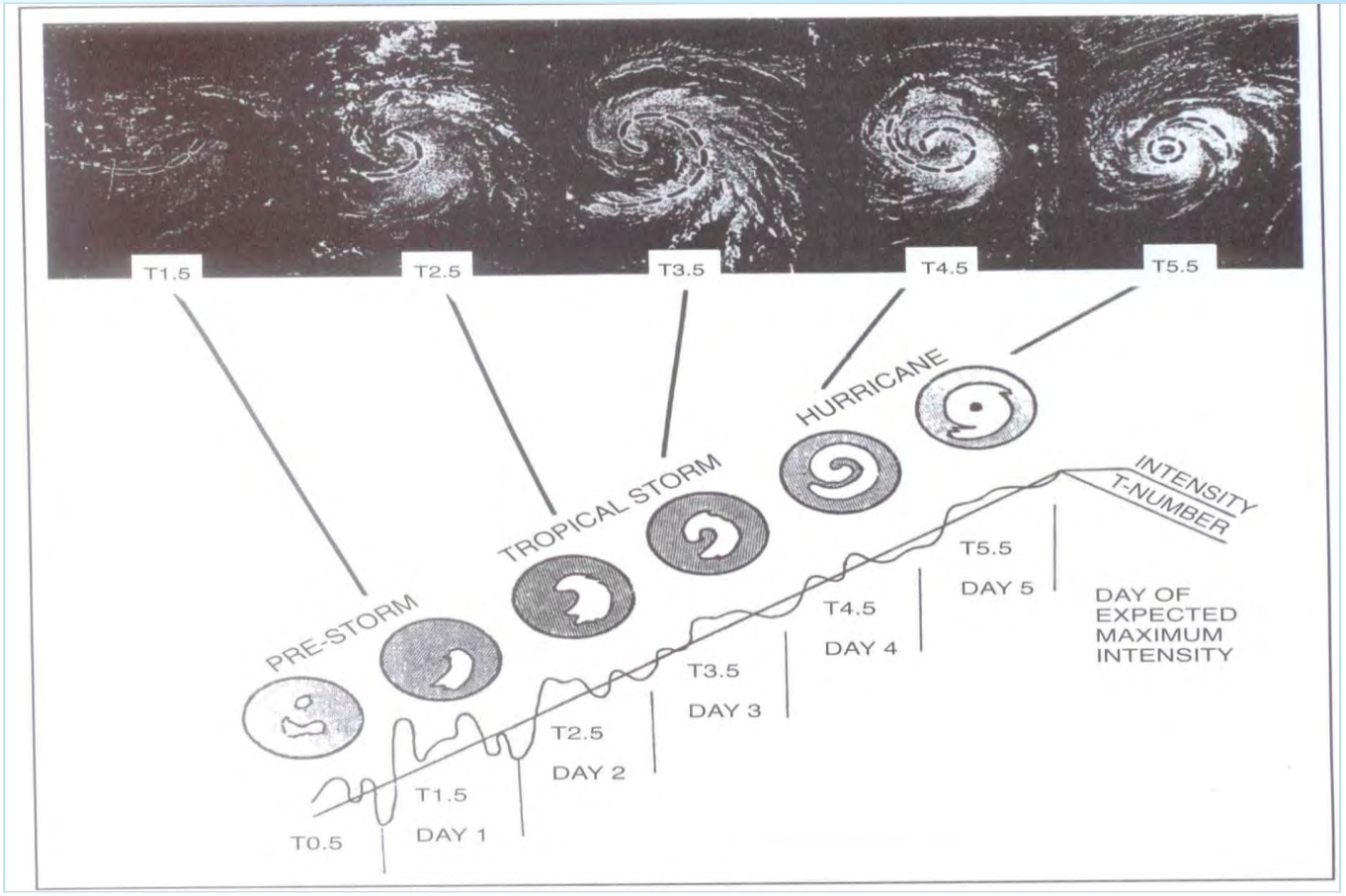
- Derived parameters are helpful for monitoring and prediction of the cyclone

Dvorak's Technique:

- T No is allotted to mention the intensity of low pressure systems.
- T.No.is derived based on pattern recognition from satellite cloud imagery.
- T No varies from 1.0 to 8.0 at the interval of 0.5
- For a low pressure system to be termed as cyclonic storm T.No. has to be 2.5 or more.

Dvorak's Technique to determine the Intensity of the storm

T8- 890m170 kts
T7- 921mb 140kts
T6- 940mb 115kts
T5- 970mb 90kts
T4- 987mb 60kts
T3- 1000mb 45kts
T2- 1009mb 30kts
T1- 25kts

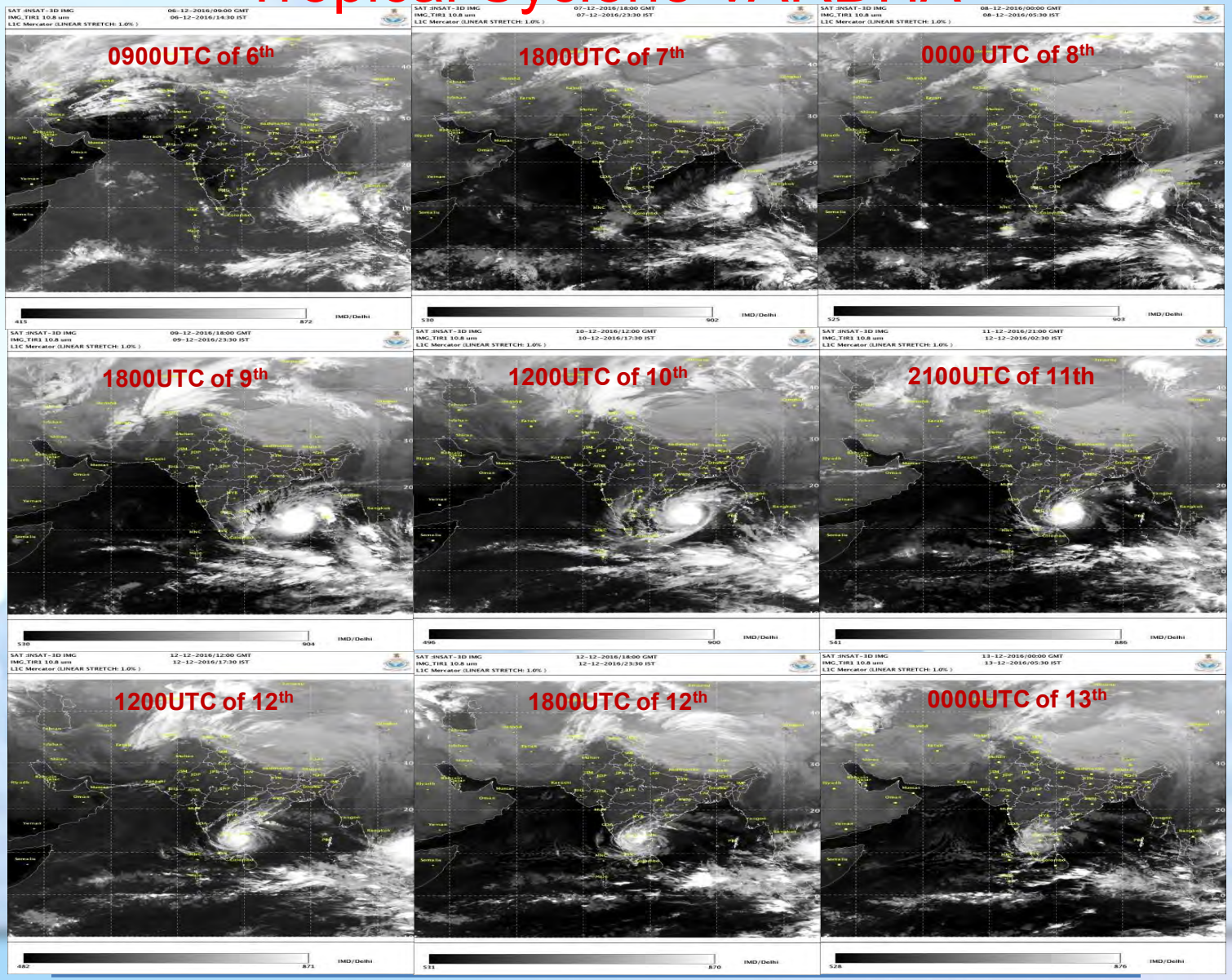


The organization of tropical cyclone as seen by satellite (from Dvorak 1984)

T.No and Associated Intensity of system

T.No	Wind Speed in Knots	Intensity of the System
1.0	< 17	Low
1.5	17-27	Depression
2.0	28-33	Deep Depression
2.5-3.0	34-47	Cyclonic Storm
3.5	48-63	Severe Cyclonic Storm
4.0-4.5	64-90	Very Severe Cyclonic Storm
5.0-6.0	91-119	„
> 6.5	>120	Super Cyclone

Tropical Cyclone VARDHA



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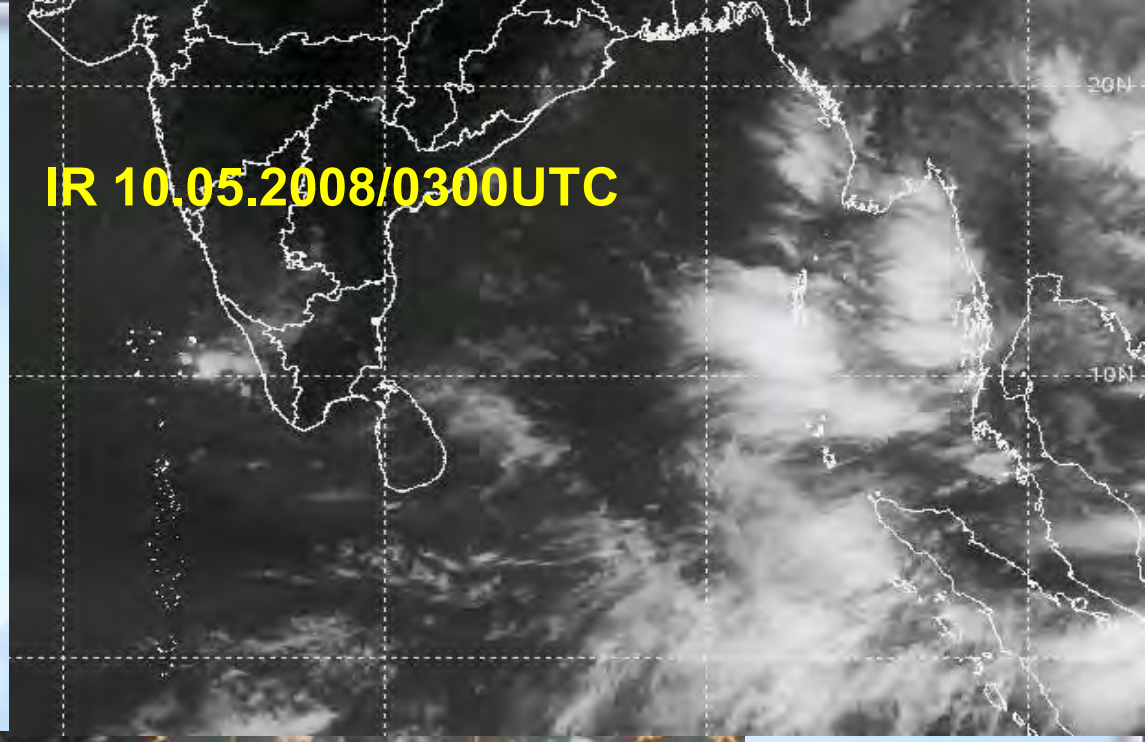
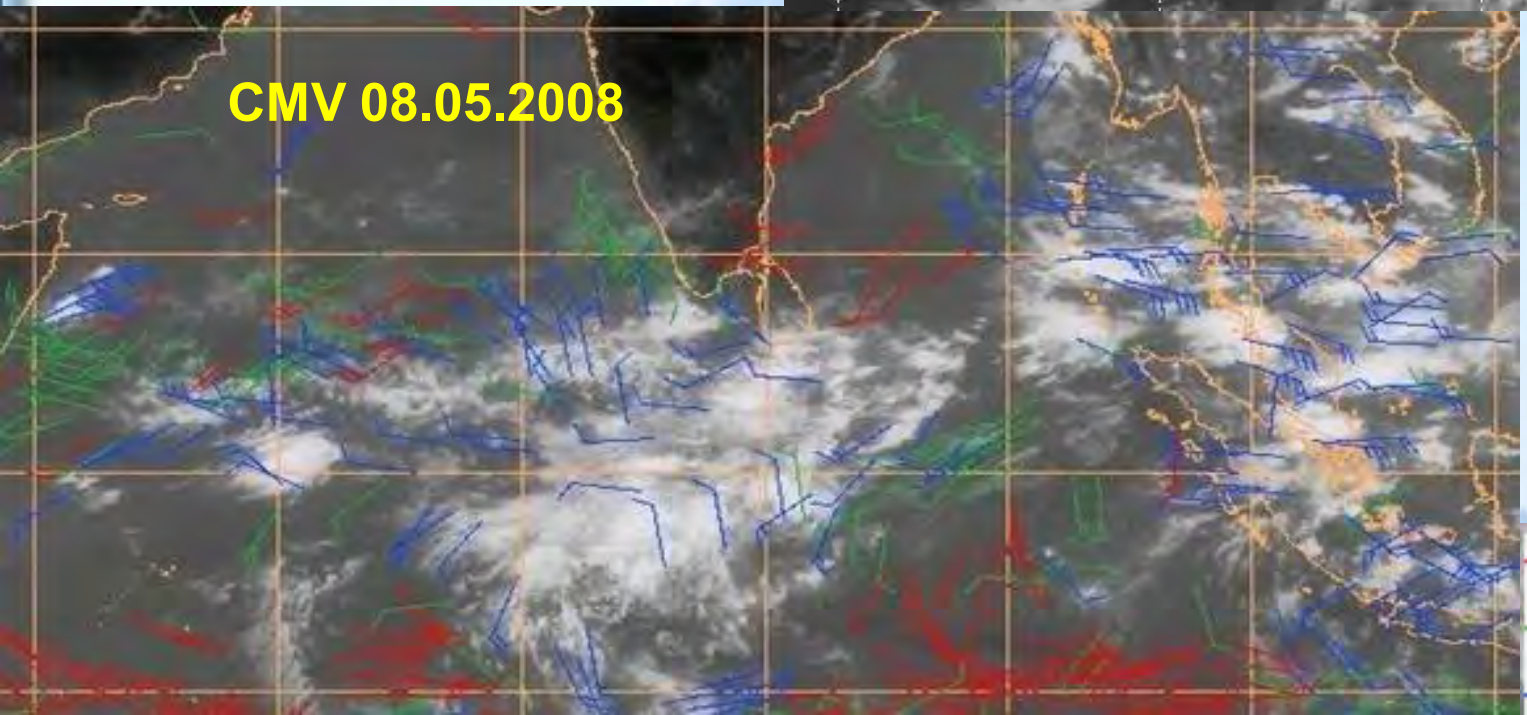
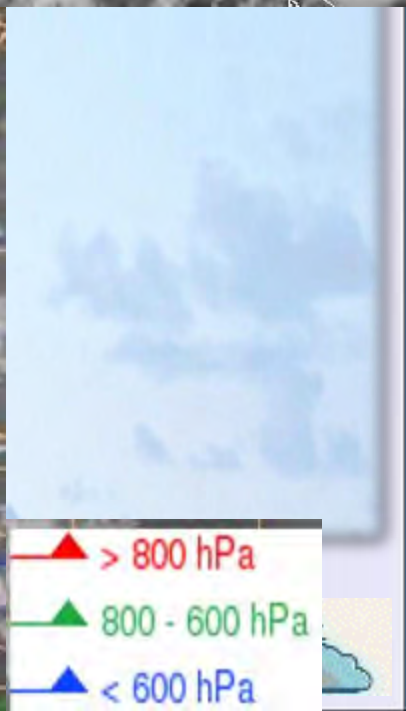
INDIA METEOROLOGICAL DEPARTMENT

Onset of SW-Monsoon over SE Bay and Nicobar Islands on10th and by 12th May Andaman islands were also covered:

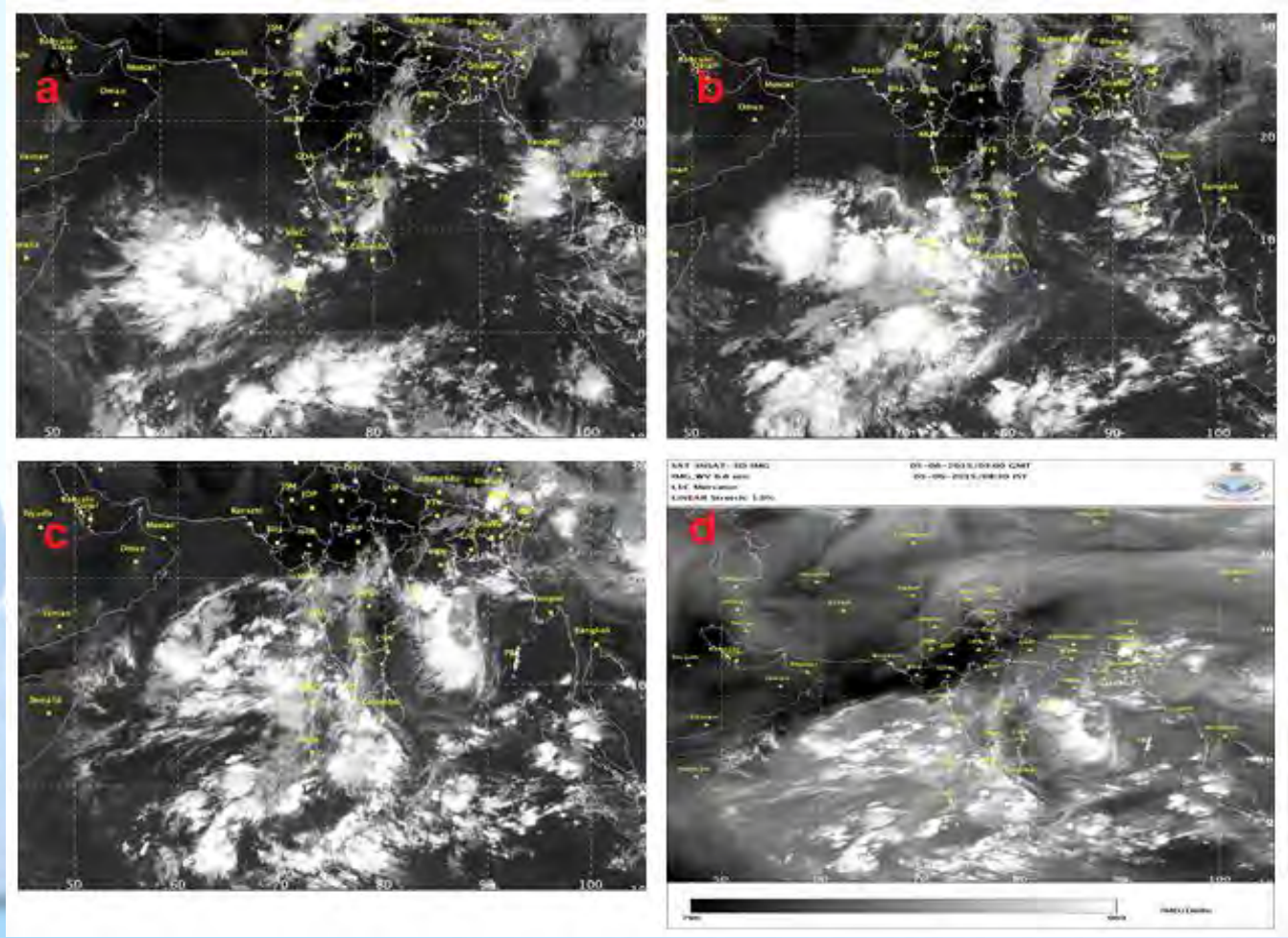
Active cross equatorial flow and formation of vortex(11 -15 May) over Andaman Sea causing moderate to intense convection and may resulted early advance of monsoon over the Area.



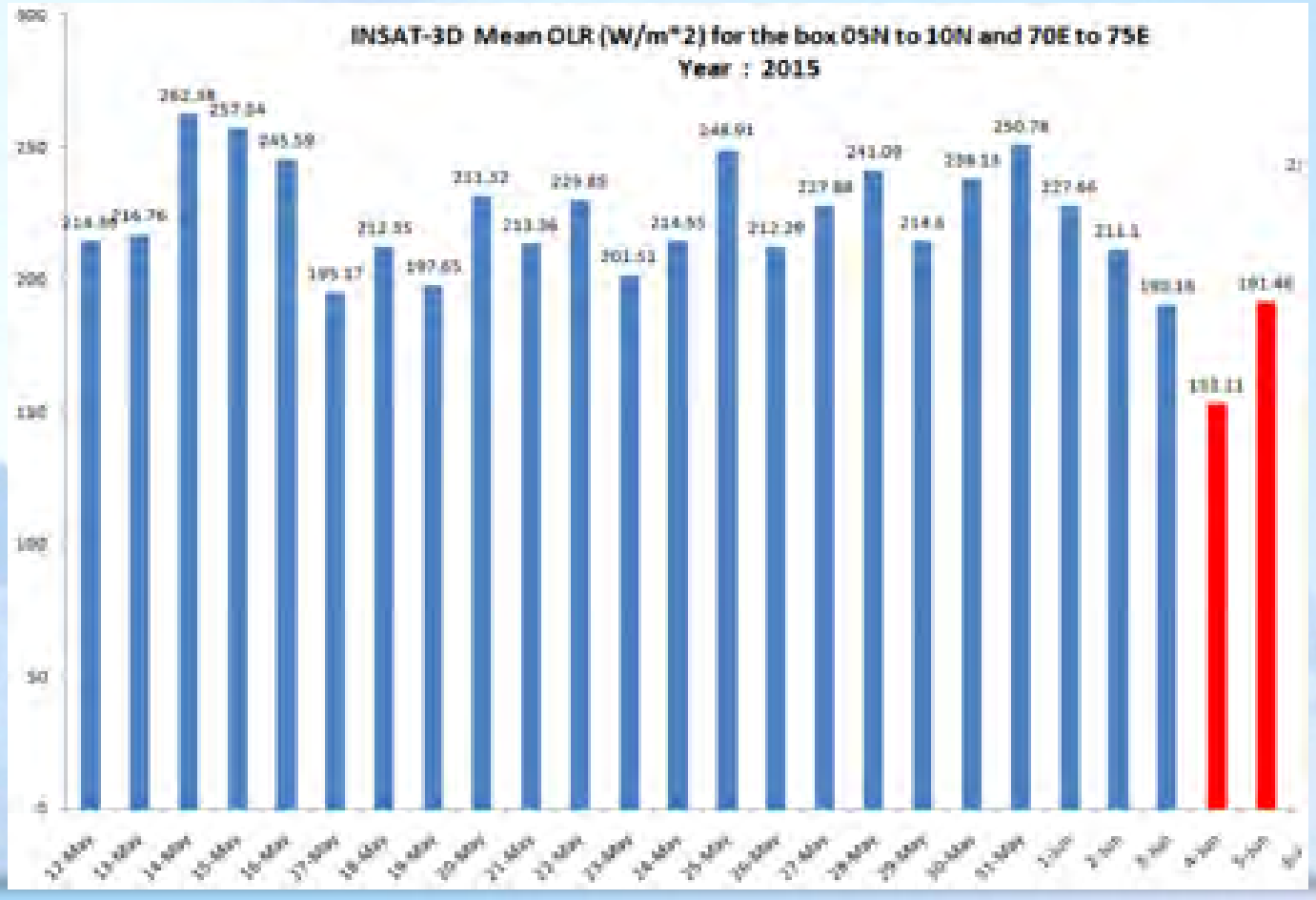




Cloud Bands Associated With Onset Of Monsoon



OLR Values Monitoring For Monsoon Onset



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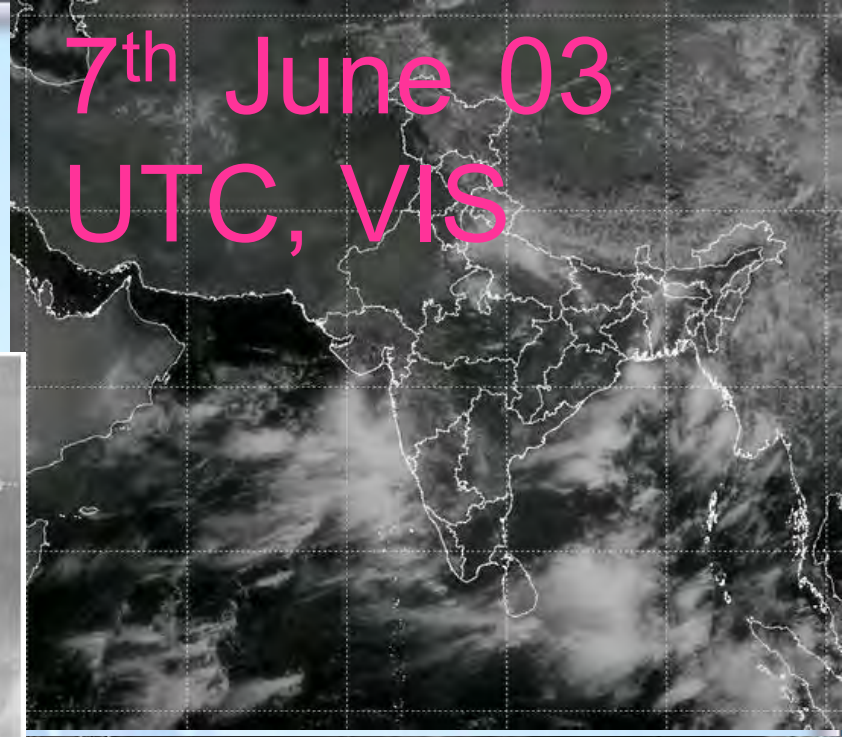
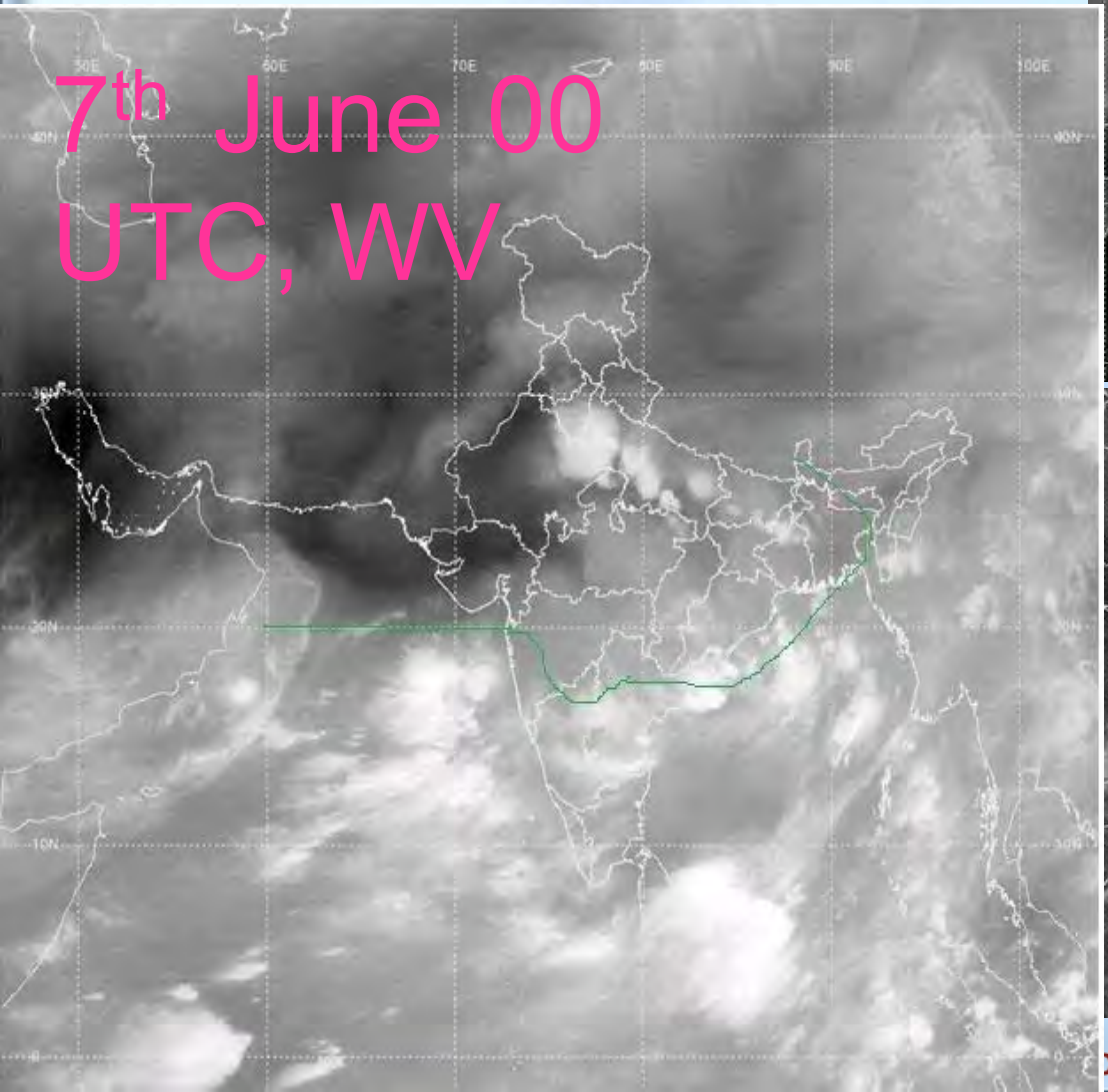
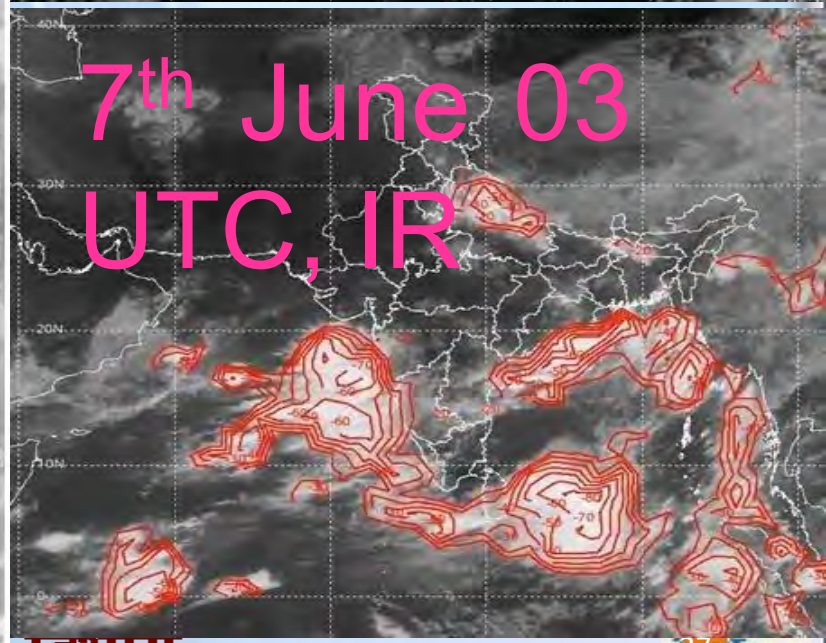
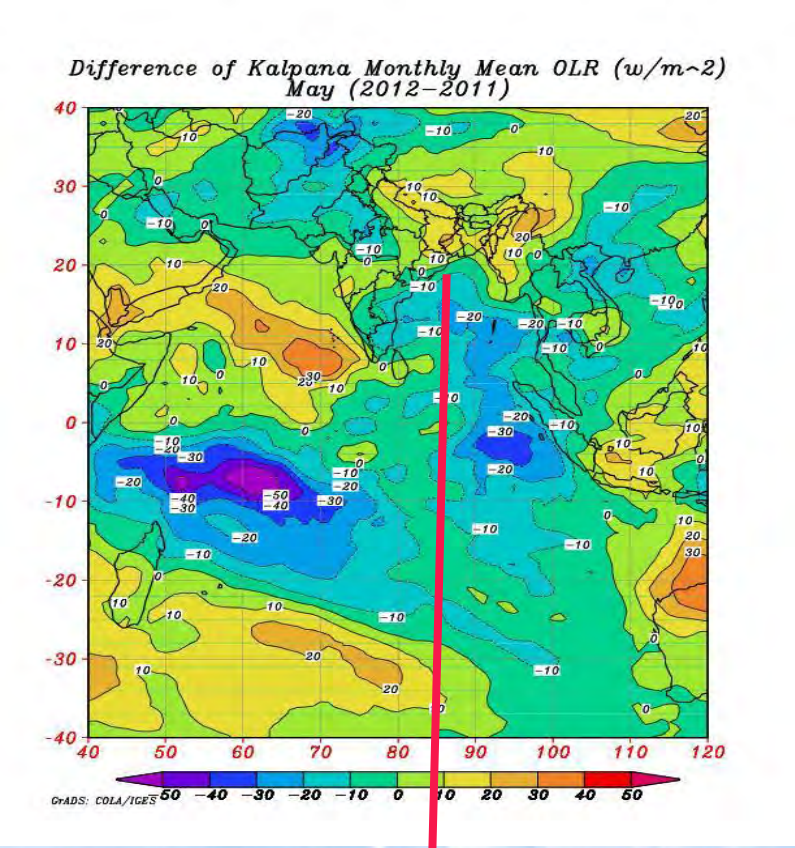
Progress of monsoon as seen through Satellite imageries.



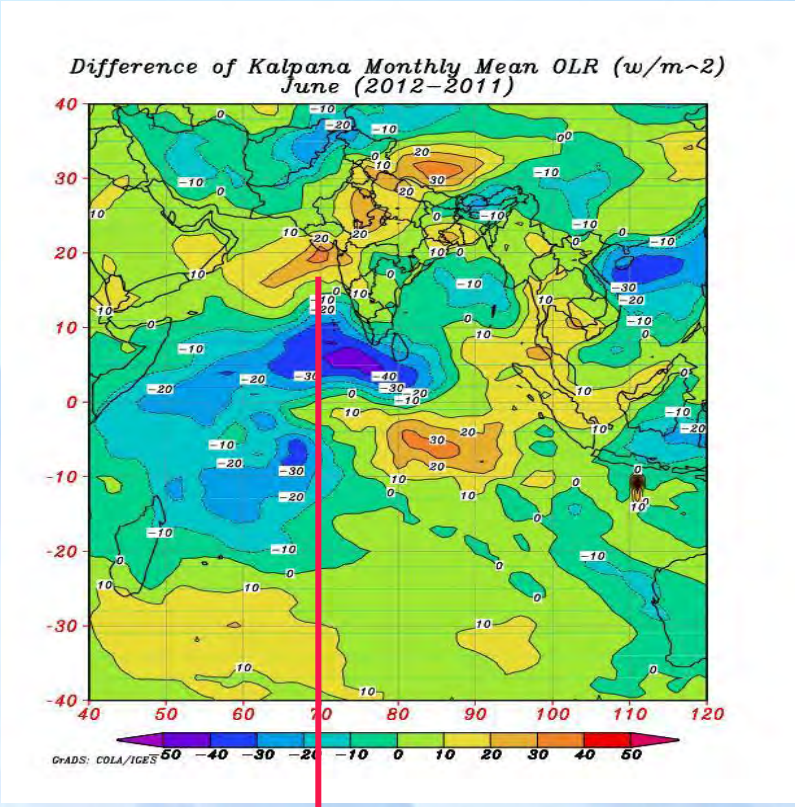




Mean monthly anomaly of OLR

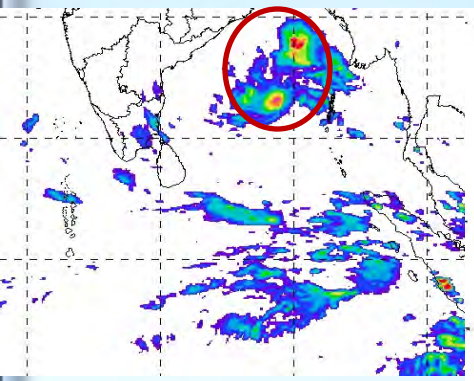


positive difference of OLR of 30-35 watt/m2 indicates less cloudiness around the selected area in May 2012 as compared to the year 2011

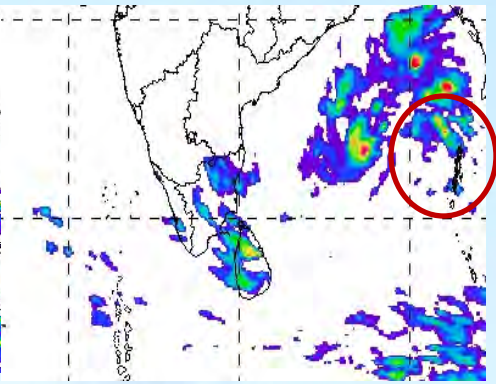


Negative difference of OLR of 40 watt/m2 indicates More cloudiness around the selected area in June 2012 as compared to the year 2011

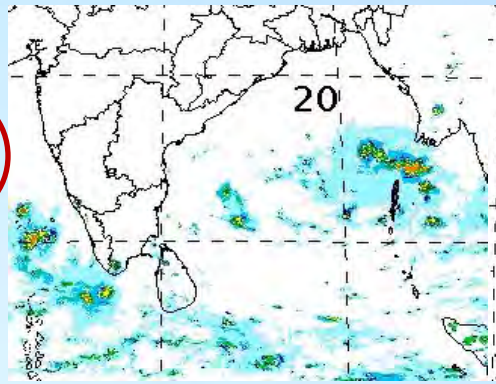
IMR 0900 UTC



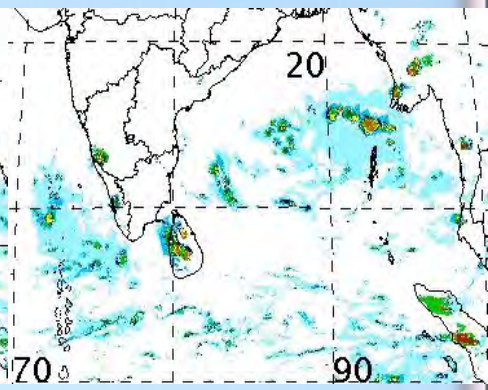
1200 UTC



HEM 0900 UTC



1200 UTC



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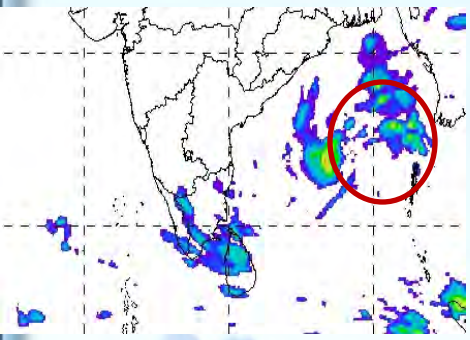

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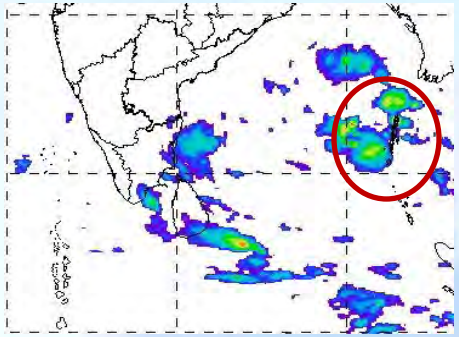

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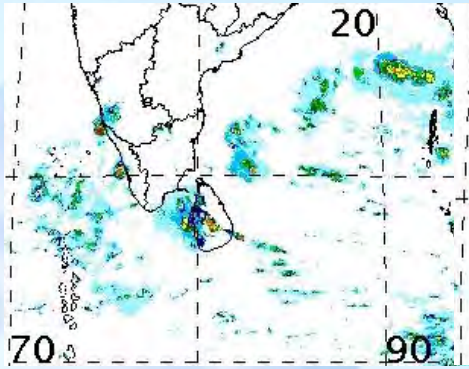

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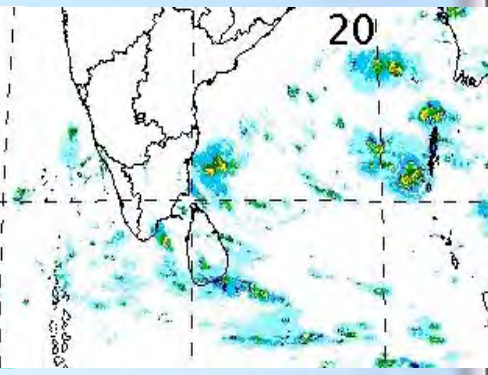
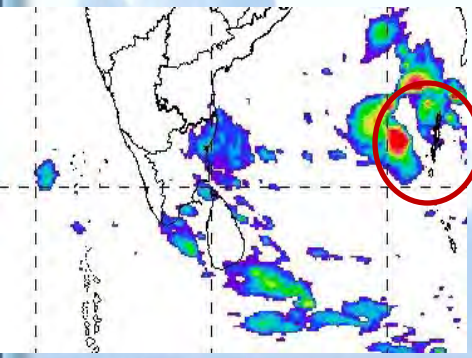
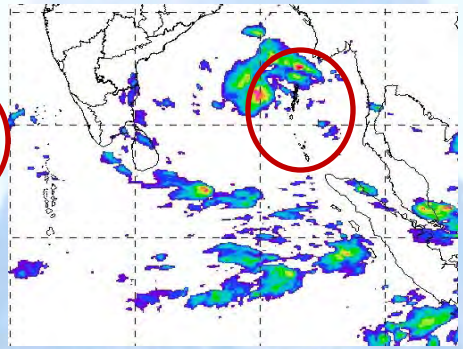
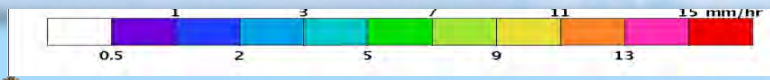


2 Nov, 0000UTC



2 Nov, 0300UTC





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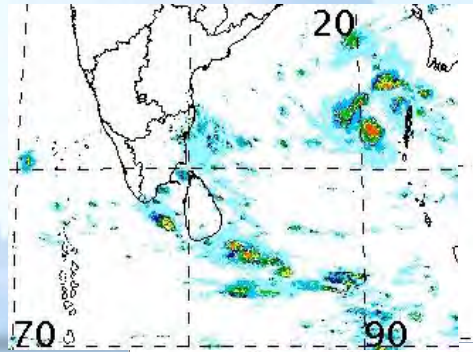

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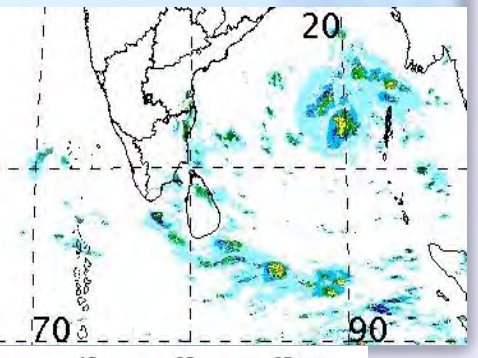
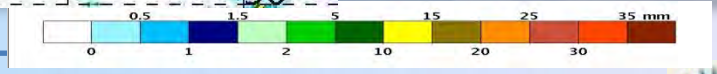


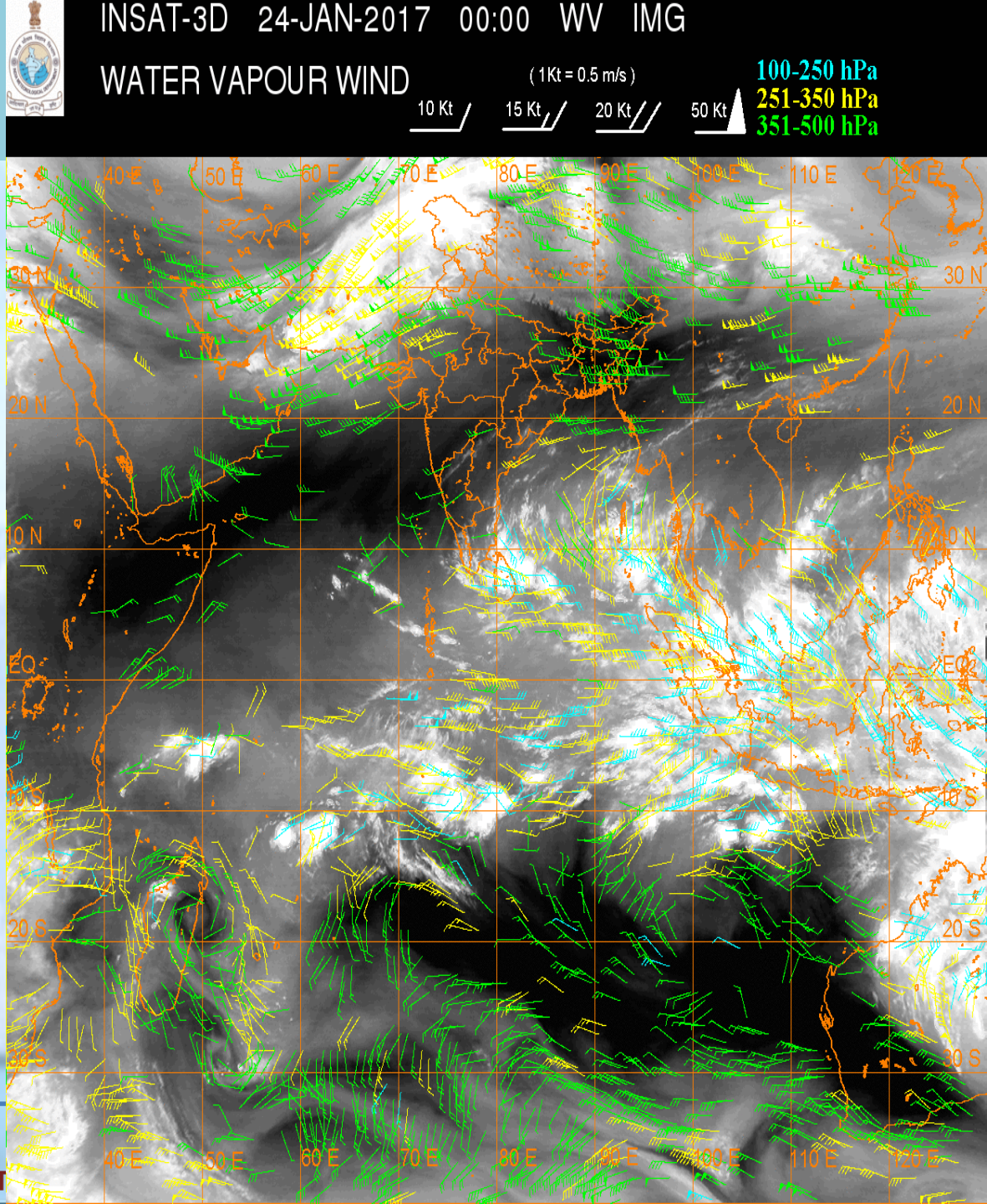


भारत मौसम विज्ञान विभाग

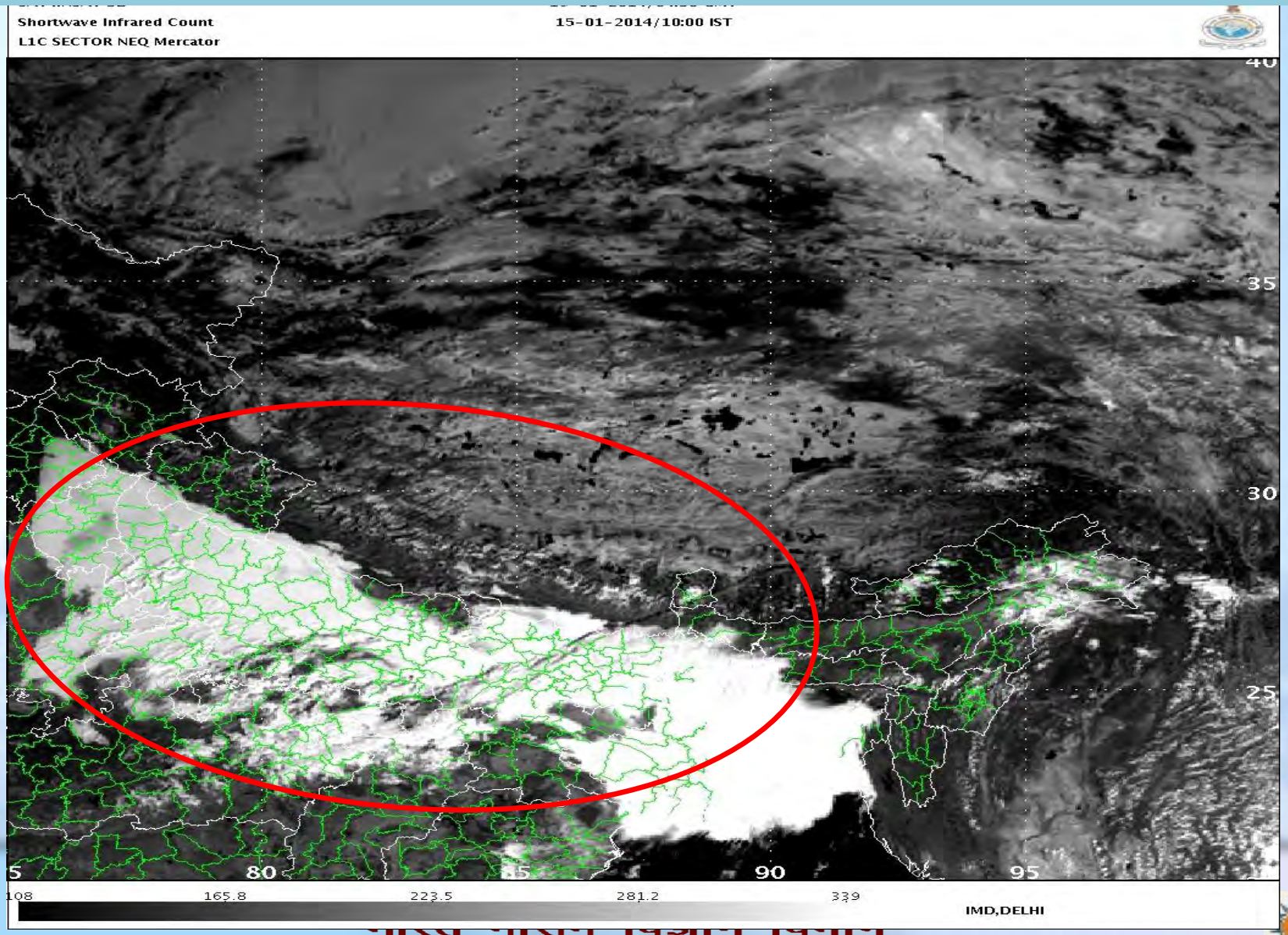
INDIA METEOROLOGICAL DEPARTMENT

Western Disturbance

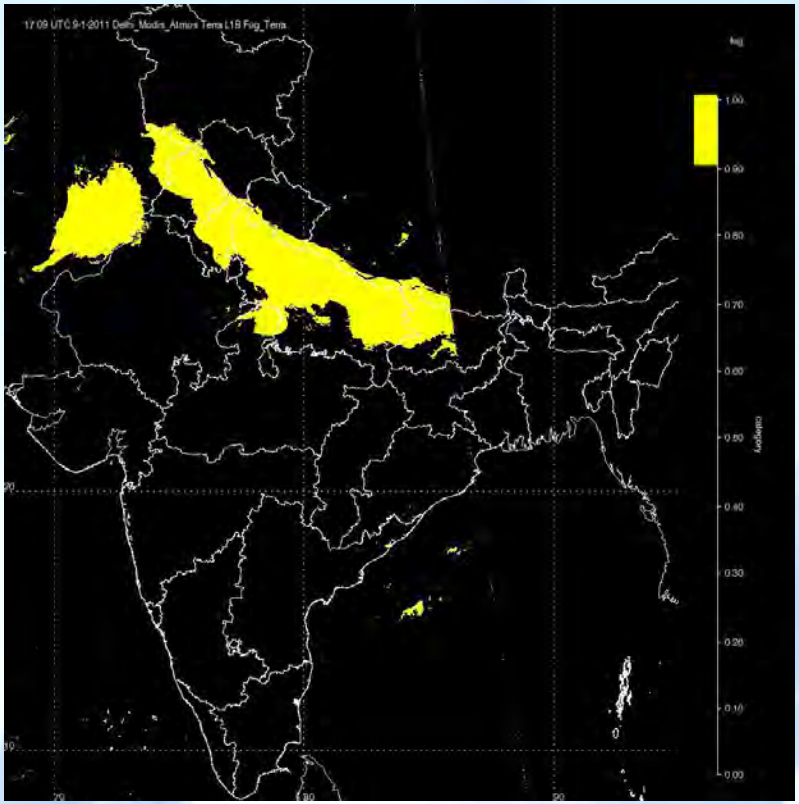
The movement of associated trough can be seen using WV winds (24 – 27 Jan 2017)



District Wise Day Time SWIR imageries (1 Km)



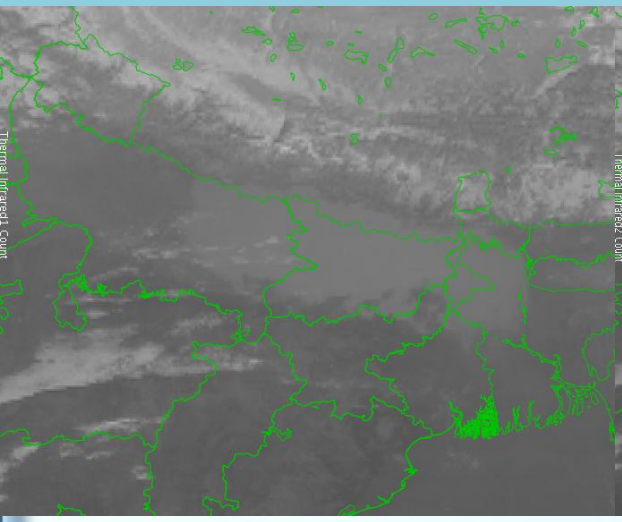
NIGHT TIME FOG DECTECTION USING MODIS/NOAA CHANNELS



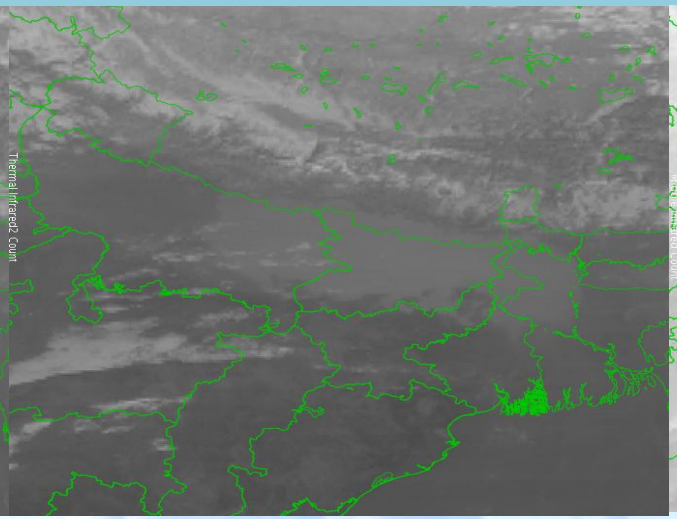
During the night-time, fog and low-stratus cloud emissivity results in a positive difference between the window IR channel 31 and channel 20. A pixel is classified as fog/low-stratus if this value > 2.5K.

name = Fog_Aqua
satellite = AQU
comb = (MODIS_ch31-MODIS_ch20)
gt 2.5

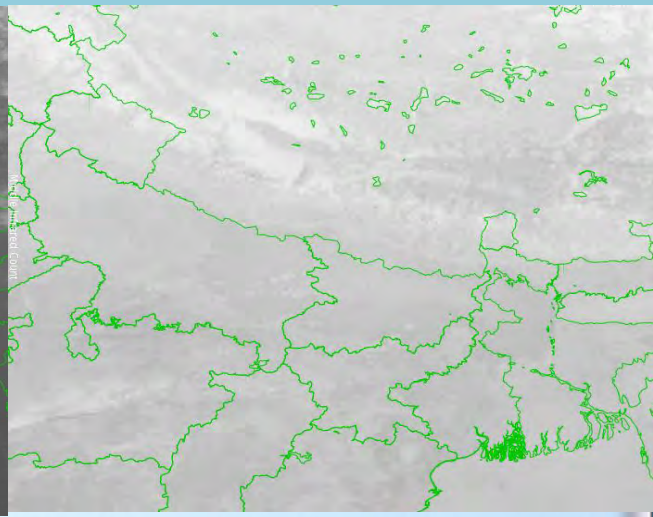
INSAT-3D Imager Channels on
10-December 2015



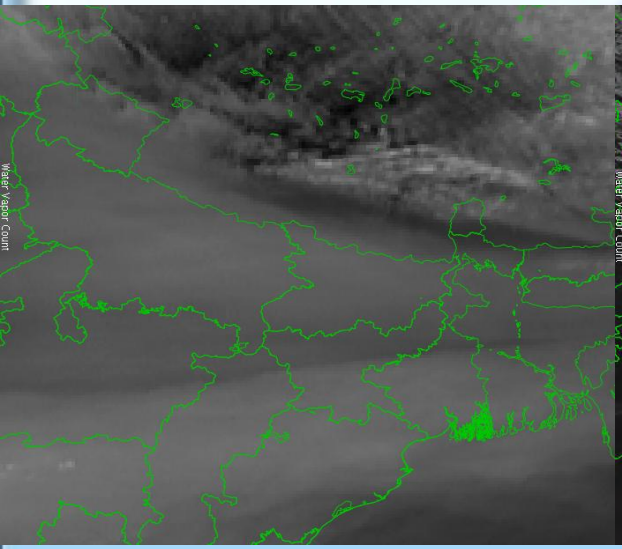
TIR-1



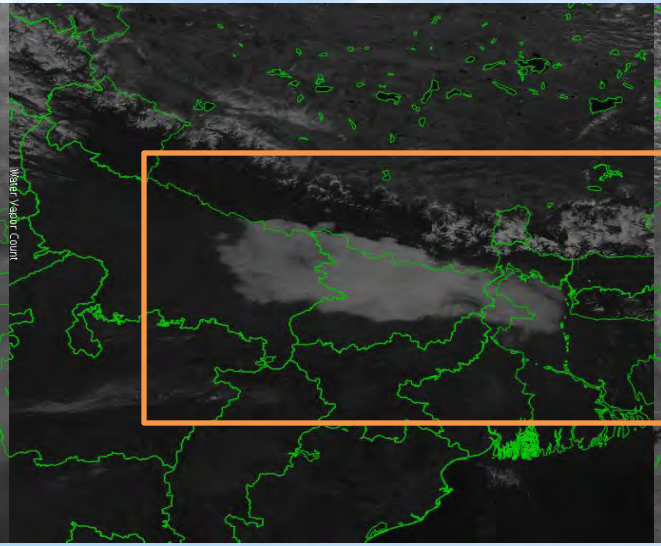
TIR-2



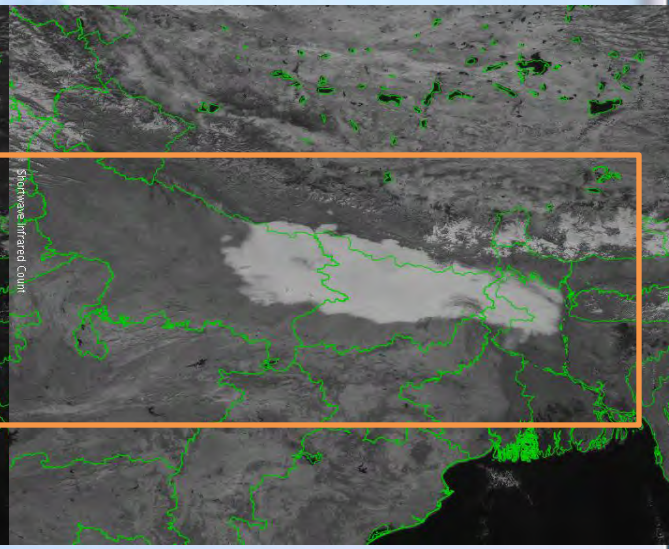
Mid-IR



WV



Visible



SWIR

भारत मौसम विज्ञान विभाग

INDIA METEOROLOGICAL DEPARTMENT

Satellite Based Nowcasting

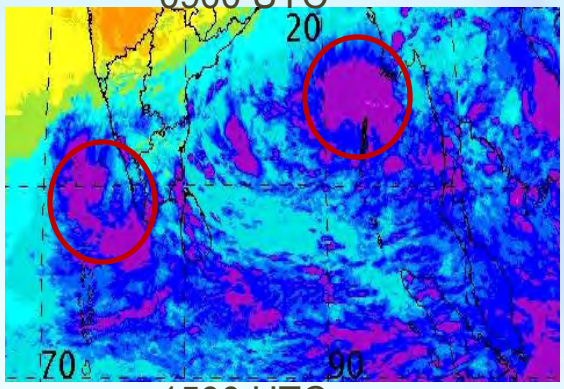
- Accurately forecasting the initiation, temporal and spatial scales, and the immediate impacts of thunderstorms remains a significant problem in various aspects of meteorology.

- Forecasters experienced that convective cloud clusters of synoptic and meso-α (200-2000km) as seen on satellite images take no less than several hours to develop, mature and dissipate, whereas single-cell thunderstorms in the cloud clusters may form and vanish in tens of minutes.

- Satellite cloud top temperature, *(It is the atmospheric temperature at the level of the cloud top)* which spans relatively longer in time, serves to indicate, to a certain extent, the life-cycle from formation to dissipation of the entire cloud cluster, and the motion of the cloud cluster also hints the large-scale movement of the entire system.

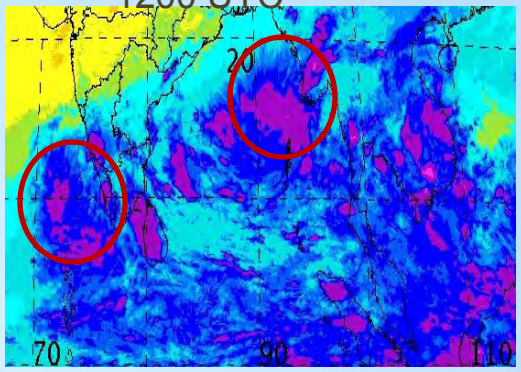
OLR VALUES (HALF HOURLY/HOURLY)

0900 UTC

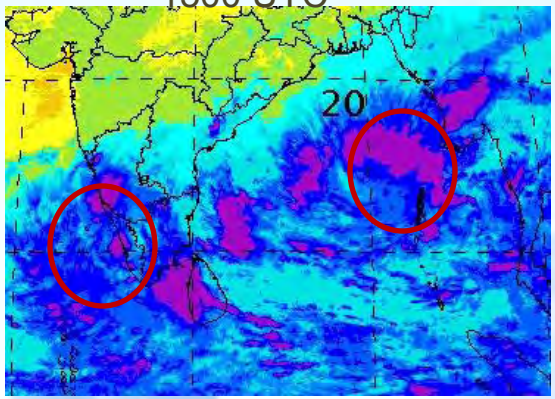


Deep convective clouds are usually identified by their cold cloud tops which emit low values of outgoing longwave radiation (OLR)

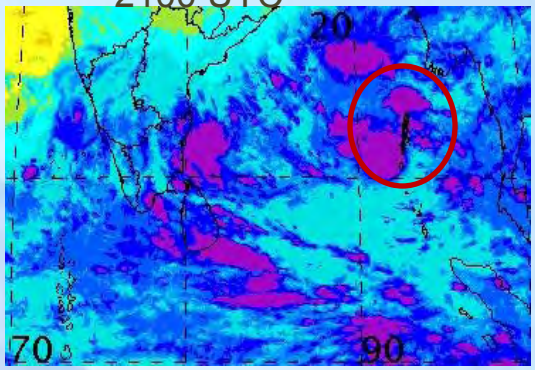
1200 UTC



1500 UTC



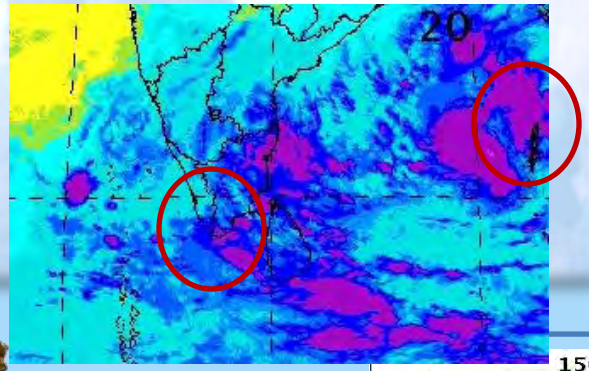
2100 UTC



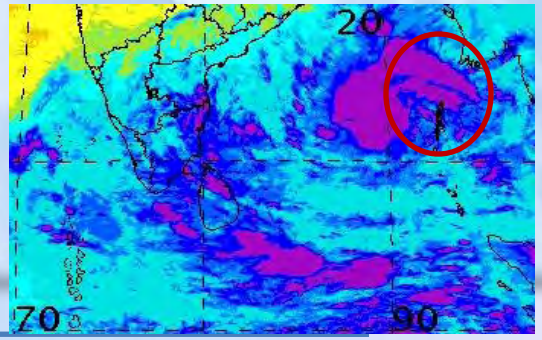
OLR Values Less than

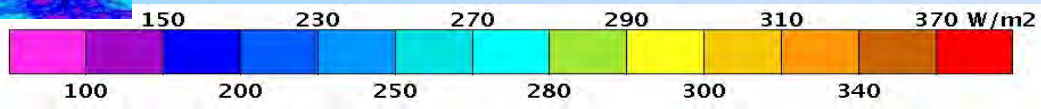
< 150-160

2 Nov, 0000 UTC

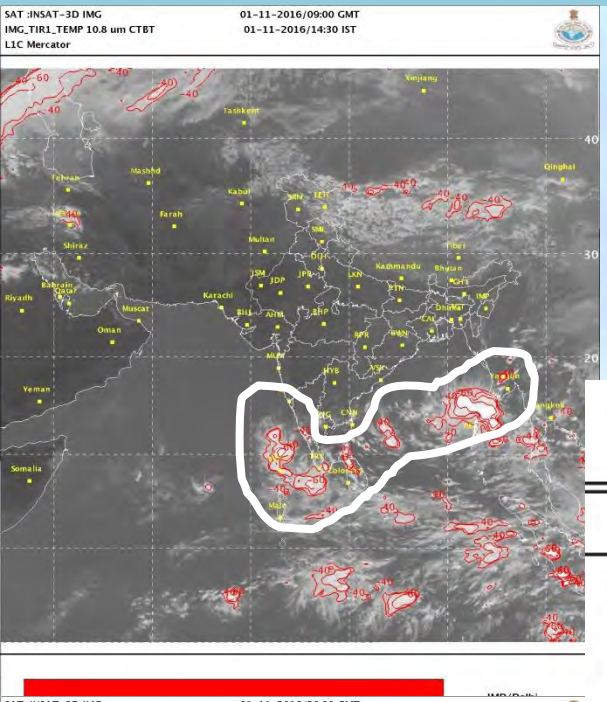


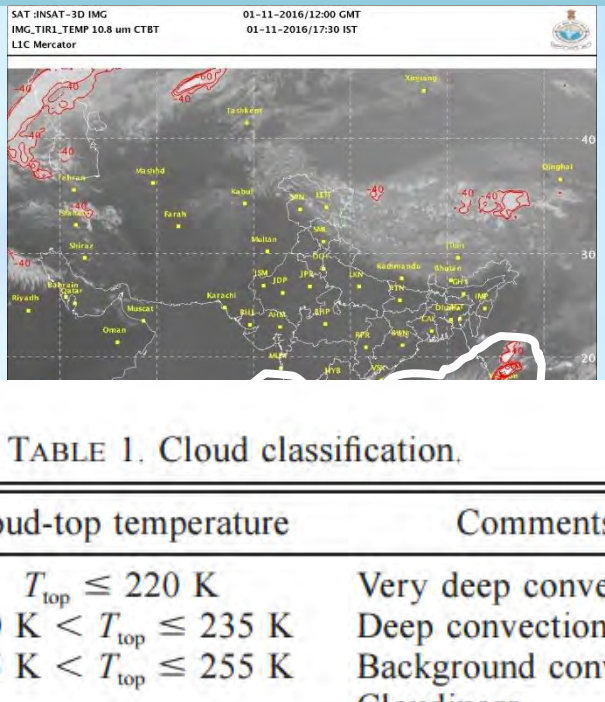
2 Nov, 0300 UTC





CTT VALUES (HALF HOURLY/HOURLY)





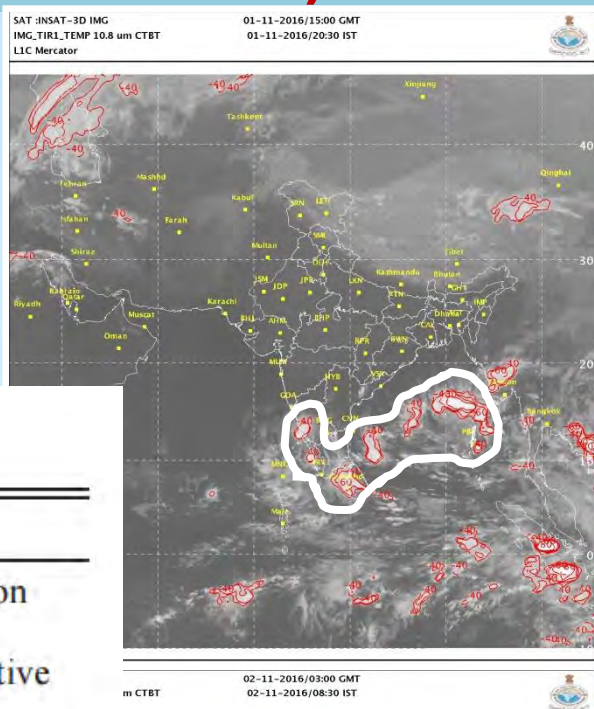
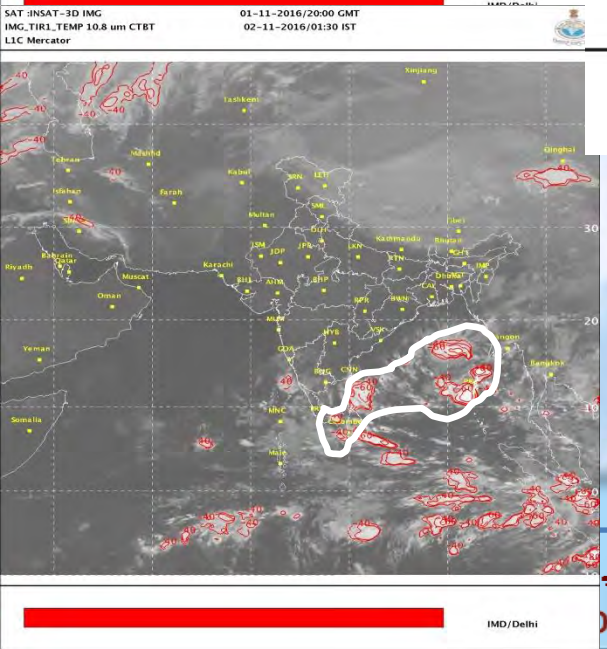


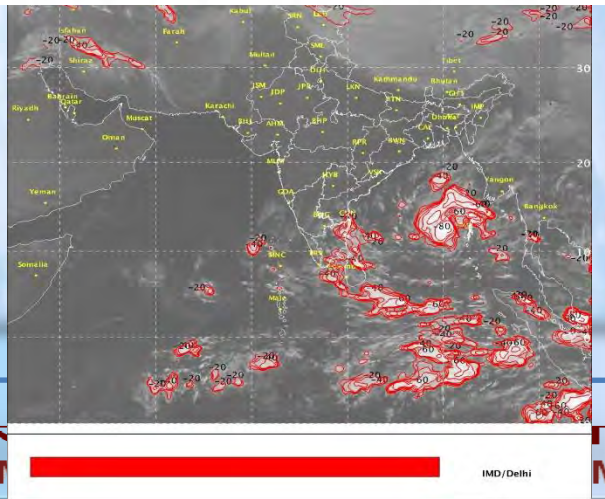
TABLE 1. Cloud classification.

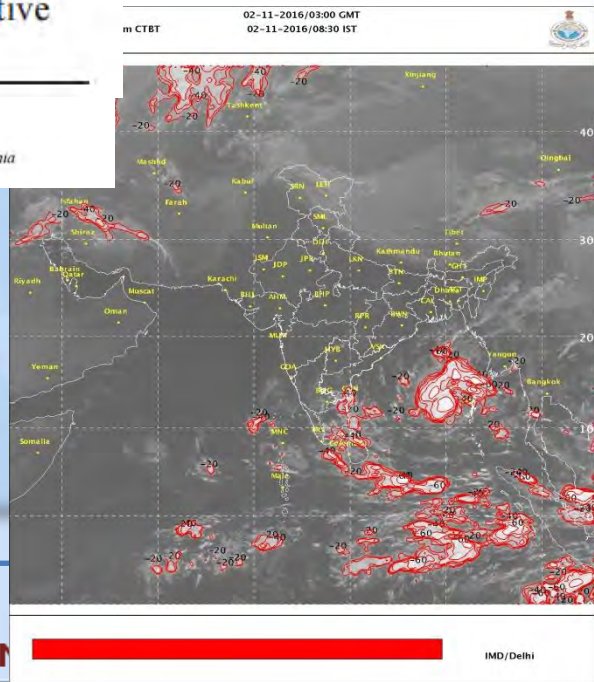
Cloud-top temperature	Comments
$T_{top} \leq 220$ K	Very deep convection
220 K $< T_{top} \leq 235$ K	Deep convection
235 K $< T_{top} \leq 255$ K	Background convective Cloudiness

RÉMY ROCA+ AND V. RAMANATHAN

Center for Cloud Chemistry and Climate, Scripps Institution of Oceanography, La Jolla, California

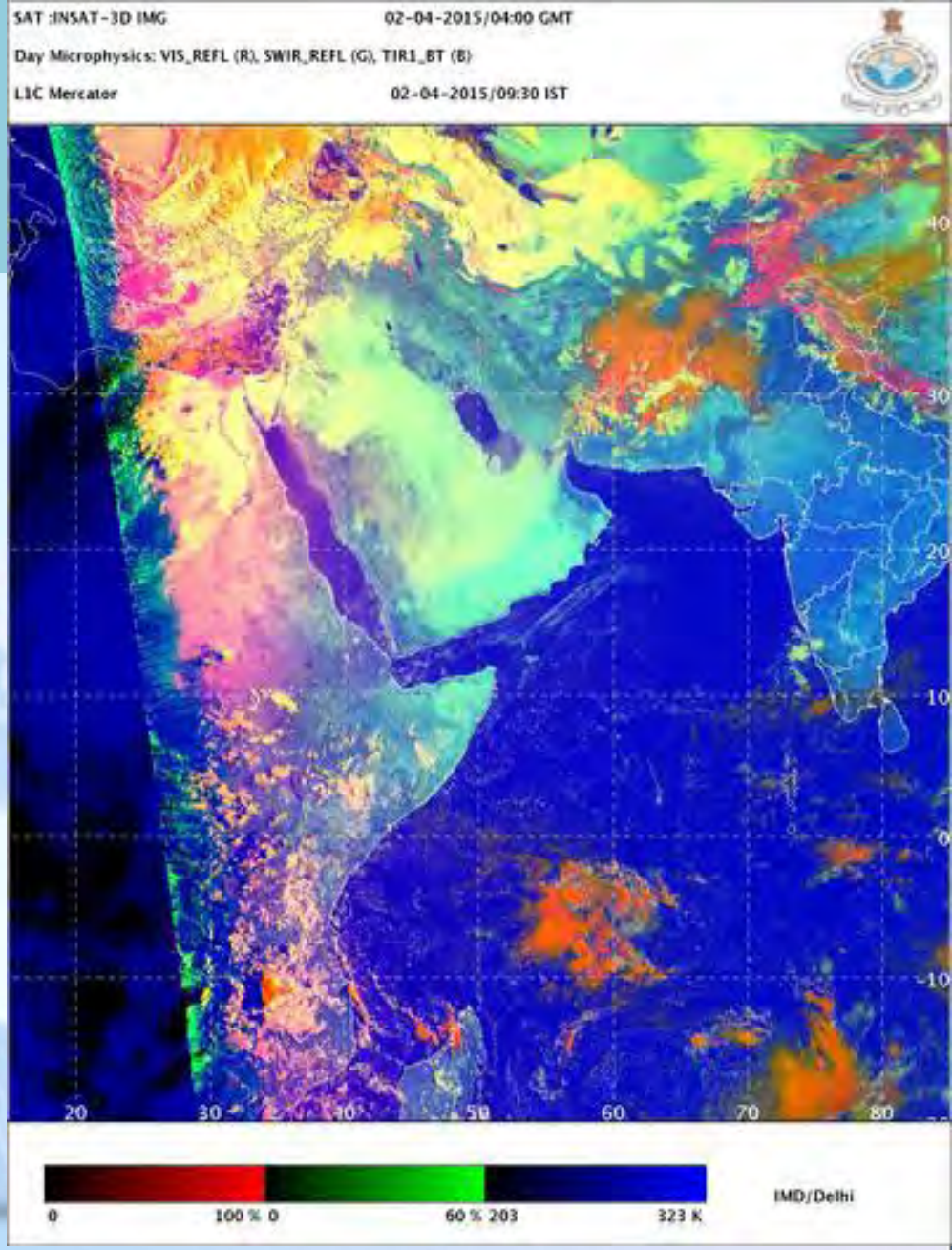






Dust Storm

Detection of Dust flow from Arabian Peninsula to north India.



Other Parameters

Parameter	Resolution	Expected Accuracy
Temperature profile	30 km x 30 km (3 x 3 Pixels)	
	30-vertical pressure levels*	1 - 2 °C
Water vapour profile	30 km x 30 km (3 x 3 Pixels)	
	21-vertical pressure levels	
	upto 100 hPa	~30%
Ozone profile	30 km x 30 km (3 x 3 pixels)	
	40 vertical pressure levels	
Total Column Ozone	30 km x 30 km (3 x 3 pixels)	~ 5-10 % Dob unit
Surface skin temperature	30 km x 30 km (3x 3 pixels)	~ 0.5 –1 °C

- Algorithm has option for retrieved at 30 km (3 x 3 pixels) and 10 km resolution (each pixel).
- *Vertical Pressure Levels (40) in hPa :*
- *1000, 950, 920, 850, 750, 700, 670, 620, 570, 500, 475, 430, 400, 350, 300, 250, 200, 150, 135, 115, 100, 85,70,60, 50, 30, 25, 20, 15, 10, 7, 5, 4, 3, 2, 1.5, 1, 0.5, 0.2, 0.1*

Thank You