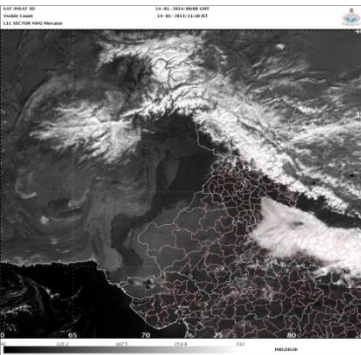
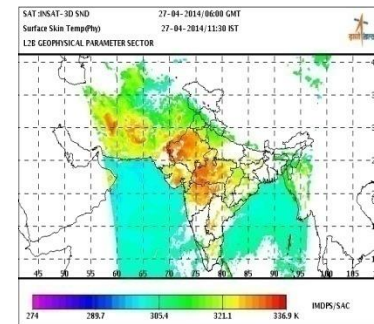


# Status report on the INSAT-3D Meteorological Data Products



Presented to CGMS-[42] [Plenary] session, agenda item [D.1]

Virendra Singh(IMD()), Dr.Rama Krishnan(ISRO)  
Director, SATMET,  
IMD, New Delhi



# Indian Meteorological Geostationary Satellites



INSAT-1D  
VHRR  
1990



INSAT-2A/2B  
VHRR  
1992/93



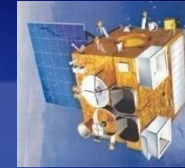
INSAT-2E  
VHRR, CCD  
1999



KALPANA-1  
VHRR  
2002



INSAT-3A  
VHRR, CCD  
2003

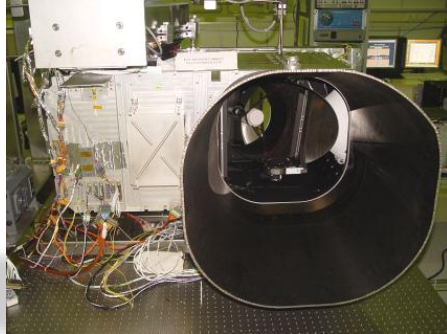


INSAT-3D  
Imager/ Sounder  
2013



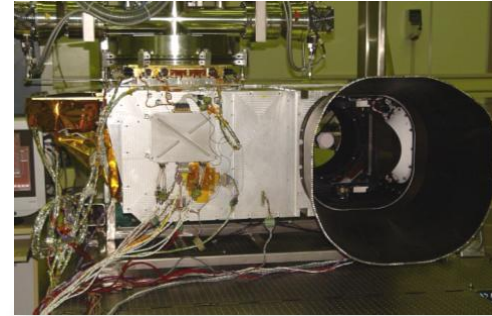
# INSAT 3D Met. Payloads

## Six channel Imager



- Visible to Thermal IR
- 1KM to 8KM IGFOV
- Half hourly earth coverage
- Flexible scanning modes
  - Programmable number of lines and frame repeats
- Improved Blackbody calibration scheme
- Image motion & Mirror motion compensation

## Nineteen channel Sounder



- Visible to Long Wave IR
- Fully programmable East-West and North –South Scan pattern
- Programmable dwell time for East-West scan step motion
- Automatic space view every 2 min and Blackbody view every 30min.
- 10KM IGFOV, 14bits digitization
- Image motion & Mirror motion compensation



## Overview – INSAT-3D payloads-IMAGER

The salient features of INAST-3D Imager are as follows:

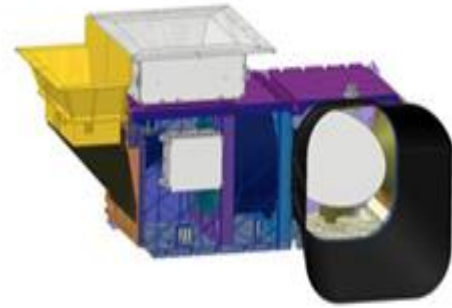
- Three flexible mode of operation
- High Resolution mode: in the Fast Scan direction IFOVs are over sampled by 1.75 times.
- A biannual rotation of yaw by 180 degree has been introduced to reduce the cooler patch temperature. This is to be taken care during processing

Spectral Band	Wave length $\mu\text{m}$	Ground Resolution	Quantization bits	IIFOV $\mu\text{rad}$
VIS	0.55 – 0.75	1 Km	10	28
SWIR	1.55-1.70	1 Km	10	28
MIR	3.80-4.00	4 Km	10	112
WVP	6.50-7.10	8 Km	10	224
TIR 1	10.3-11.3	4 Km	10	112
TIR 2	11.5 – 12.5	4 KM	10	112

Mode of Operation	Time of coverage	Coverage Area
<b>Full frame mode</b>	<b>26 minutes</b>	<b>18x18 degrees</b>
Programmed Normal scan mode	23 minutes	14x18degrees
Programmed Sector scan mode	6 minutes	4 degrees in NS & 18 degrees in EW



## INSAT-3D-Sounder



INSAT-3D carries a newly developed 19 channel sounder, which is the first such payload to be flown on an ISRO satellite mission. The Sounder has eighteen narrow spectral channels in shortwave infrared, middle infrared and long wave infrared regions and one channel in the visible region. The ground resolution at nadir is nominally 10x10km for all nineteen channels.

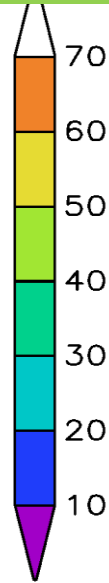
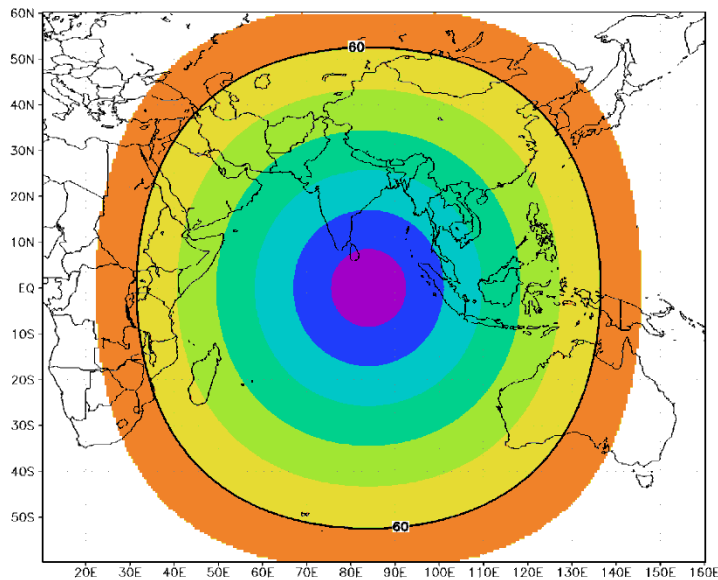
INSAT-3D Atmospheric Sounding System providing, vertical profiles of temperature at 40 levels (surface to 70 km) & Humidity at 21 levels (surface to 15 km) and integrated ozone from surface to top of the atmosphere These profiles are available for a selected region over Indian landmass every hour and for the entire Indian Ocean Region on every sixth hours

Channel	Spectral Range microns	Resolution
VISIBLE(1)	0.67– 0.72	10X 10 kms.
SWIR(6)	3.67– 4.59	10X 10 kms
MIR(5)	6.38– 11.33	10X 10 kms
LWIR(7)	11.66 – 14.85	10X 10 kms





## INSAT-3D Sounder Observations

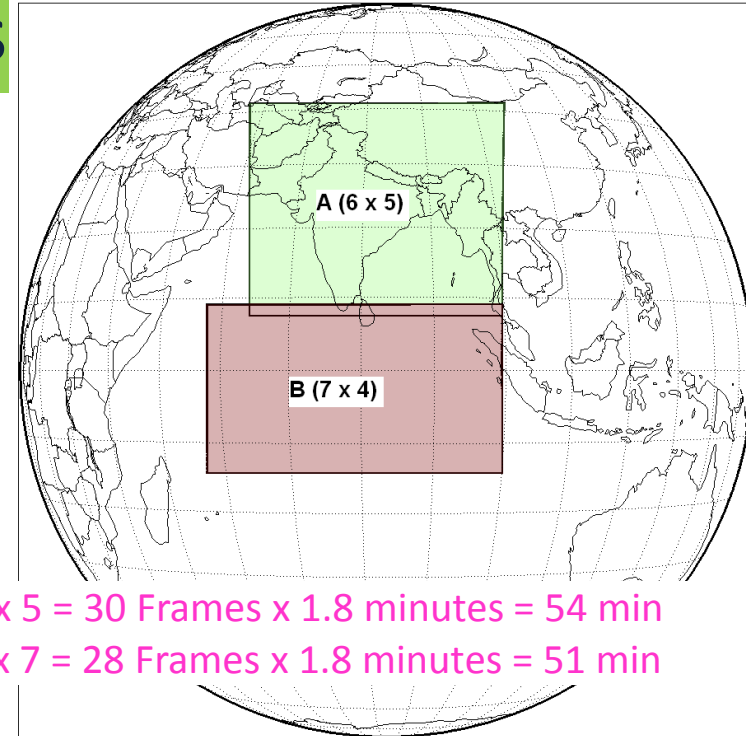


Observation zenith angle INSAT-3D,  
Sub-satellite point

6400 km x 6400 km scan takes 180 minutes

64 x 64 pixel scan takes 1.80 minutes

Sounder Observation Area



A:  $6 \times 5 = 30$  Frames x 1.8 minutes = 54 min

B:  $4 \times 7 = 28$  Frames x 1.8 minutes = 51 min

### Sounder Scan Schedule (6 Hour cycle):

00:00-00.54Z : Region A

01:00-01.54Z : Region A

02:00-02.54Z : Region A

03:00-03.54Z : Region A

04:00-04.54Z : Region A

05:00-05.51Z: Region B

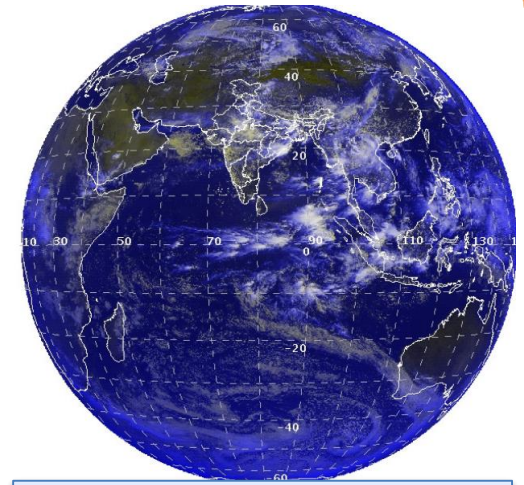
.....repeat above cycle



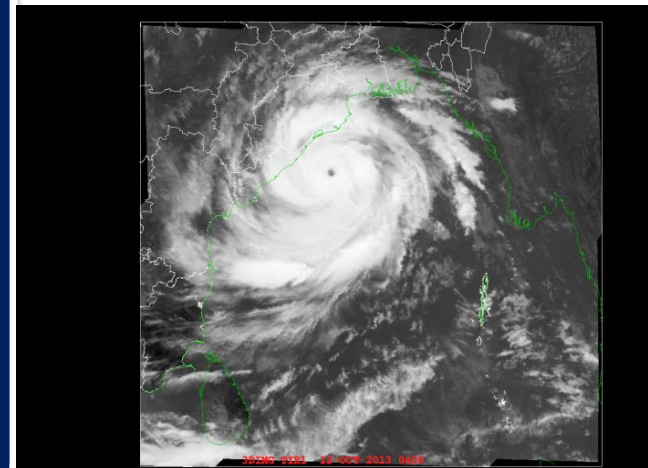
## INSAT-3D Data Processing & Dissemination System

- INSAT-3D software is installed & operational at IMD Delhi and BES SAC.
- Data Products including Geo-Physical Parameters are generated on 24 x 7
- Monthly Inter Satellite Calibration using GSICS in Operations
- MCF is providing Orbit information in every two days using two station ranging and OBT- GRT correlation file on daily basis.
- STAR sensor attitude is used as a default mode for processing for Imager and Sounder
- Monthly Inter Satellite Calibration using GSICS in Operations, Procedure for Daily Calibration done.

[www.imd.gov.in](http://www.imd.gov.in) [www.mosdac.gov.in](http://www.mosdac.gov.in)



*Imager Colour Composite*



**Phailin Cyclone –**  
12OCT2013 0400 UT



## INSAT-3D Types of Data Products

### IMAGER

Standard	L1B	Full Disk	
	L1C	Sector	
Geophysical Parameters	L2B	Per Pixel	OLR, HE, FOG, UTH, SNOW, SST
	L2P	Point	Fire, Smoke, AMV
	L2G	Gridded	IMSRA, PI, AOD
	L3	Binned	OLR, HE, SST, UTH, IMSRA, PI

### SOUNDER

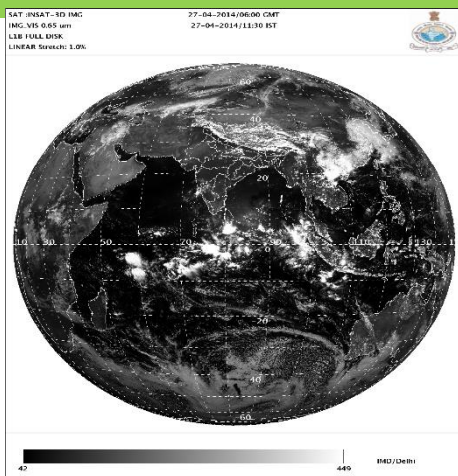
Standard	L1B	Acquired Sector	A , B
Geophysical Parameters	L2B	Per Pixel	Profiles and Derived Parameters



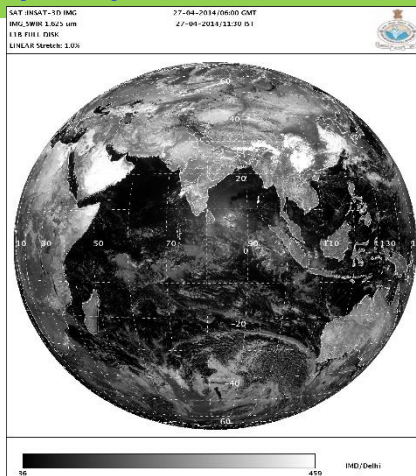


## INSAT-3D Imager

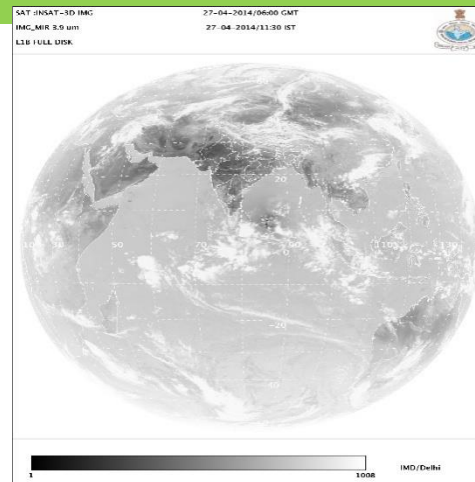
### Standard Products (L1B) viewed on 27 APR 2014 at 0600 UTC



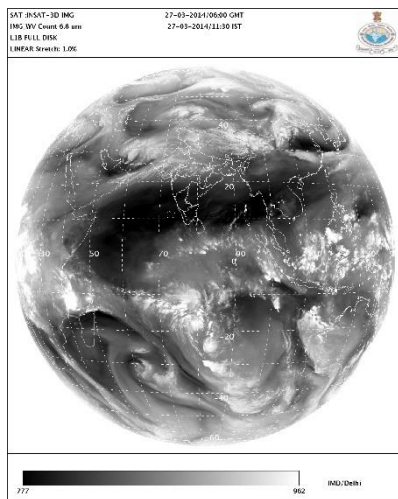
**VIS (0.55-0.75 $\mu$ m)**



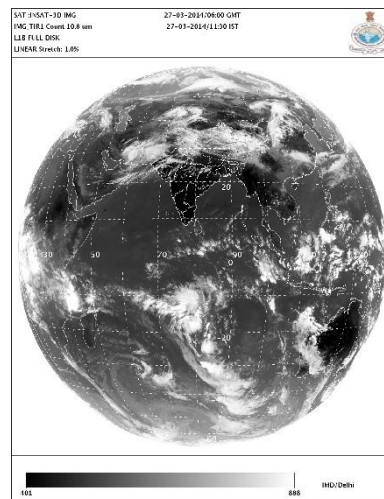
**SWIR(1.55-1.70 $\mu$ m)**



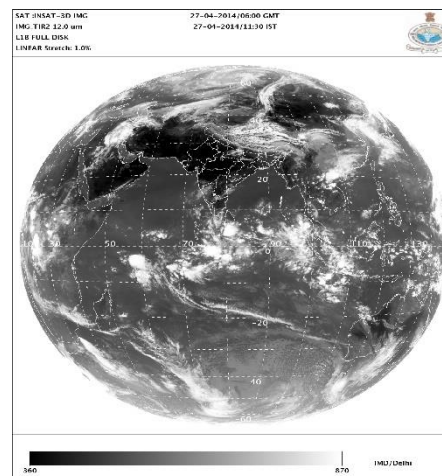
**MIR(3.80-4.00 $\mu$ m)**



**WV(6.50-7.10 $\mu$ m)**



**TIR-1(10.30-11.30 $\mu$ m)**

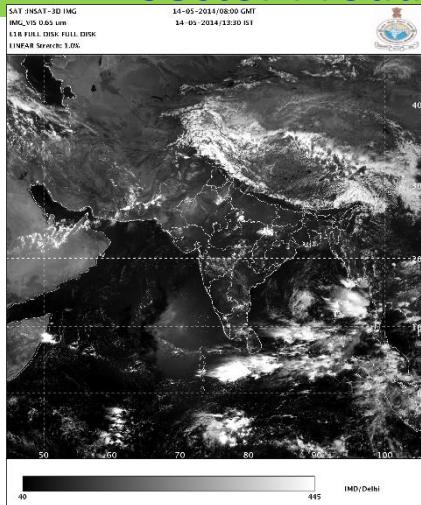


**TIR-2(11.50-12.50 $\mu$ m)**

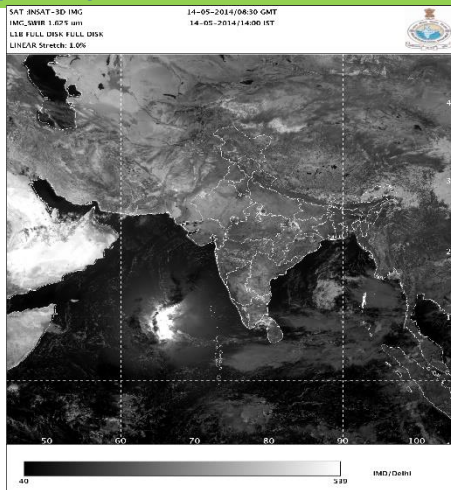


## INSAT-3D Imager

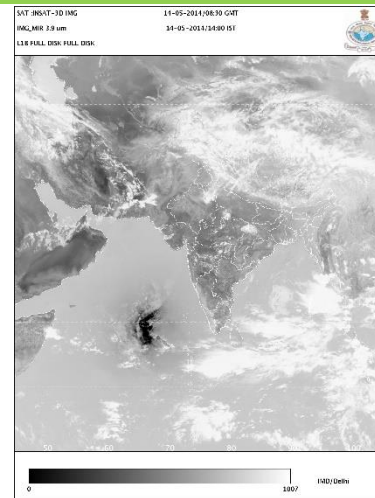
### Sector Products (L1C) viewed on 14 MAY 2014 at 0830 UTC



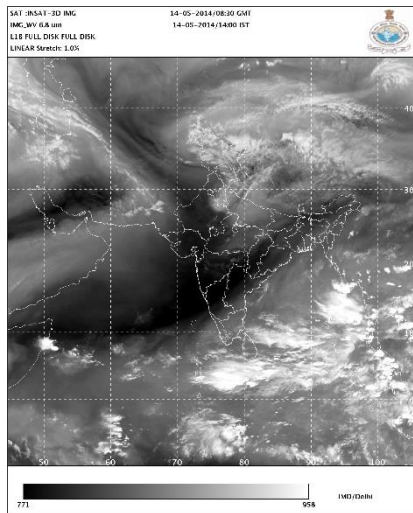
**VIS (0.55-0.75µm)**



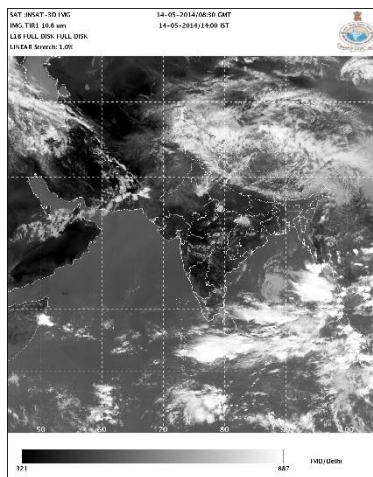
**SWIR(1.55-1.70µm)**



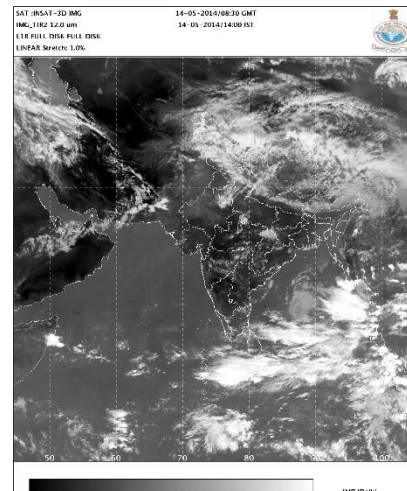
**MIR(3.80-4.00µm)**



**WV(6.50-7.10µm)**



**TIR-1(10.30-11.30µm)**



**TIR-2(11.50-12.50µm)**

**Coordination Group for Meteorological Satellites**

**IMD**



**CGMS**



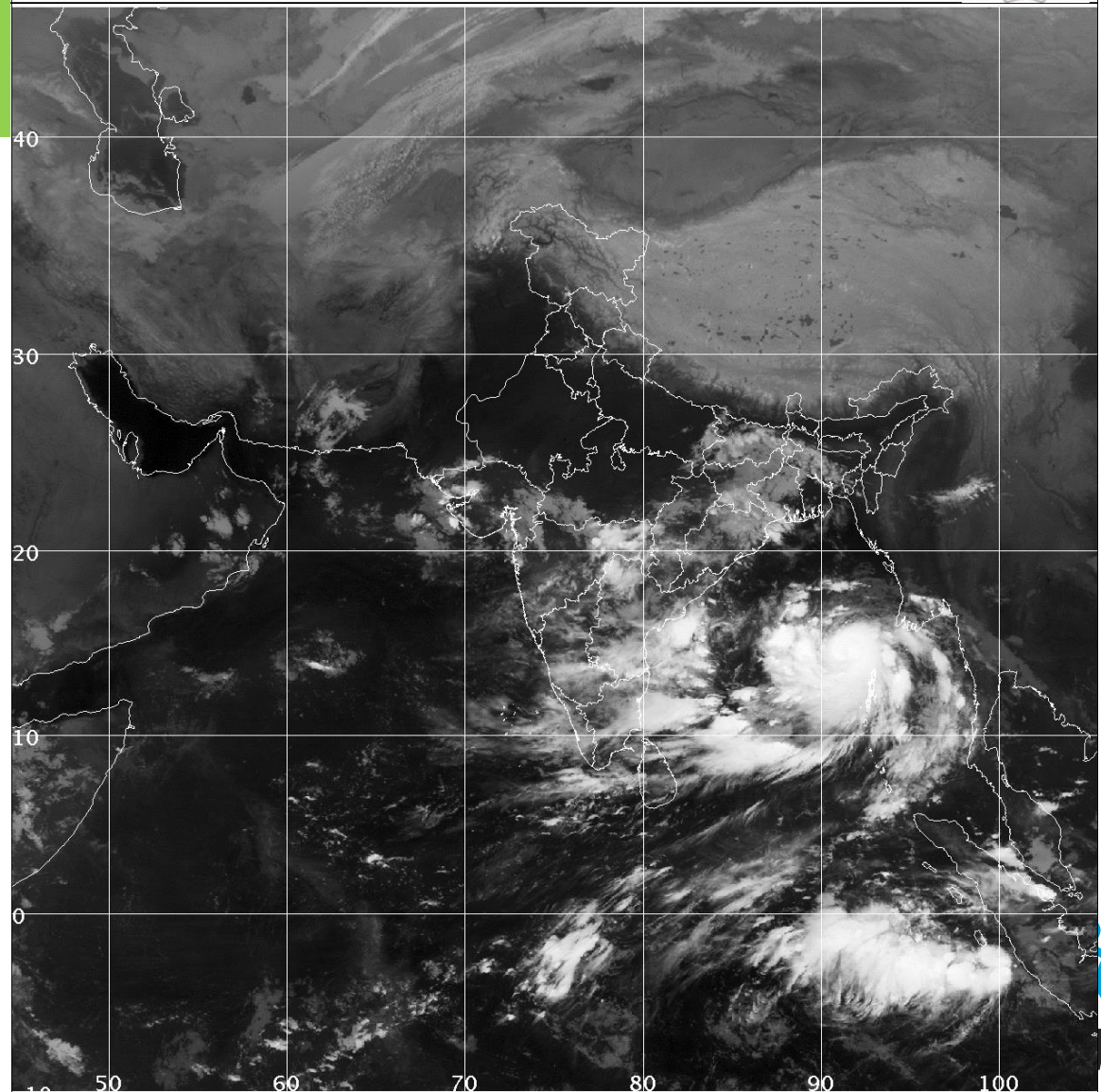


SAT : INSAT-3D IMG  
IMG\_TIR1 10.8 um  
LIC SECTOR ASIA\_MER Mercator

10-10-2013/00:00 GMT  
10-10-2013/05:30 IST



Animation of Phailin Cyclone  
(7-12 Oct, 2013) observed  
From INSAT-3D(IR-1 band)

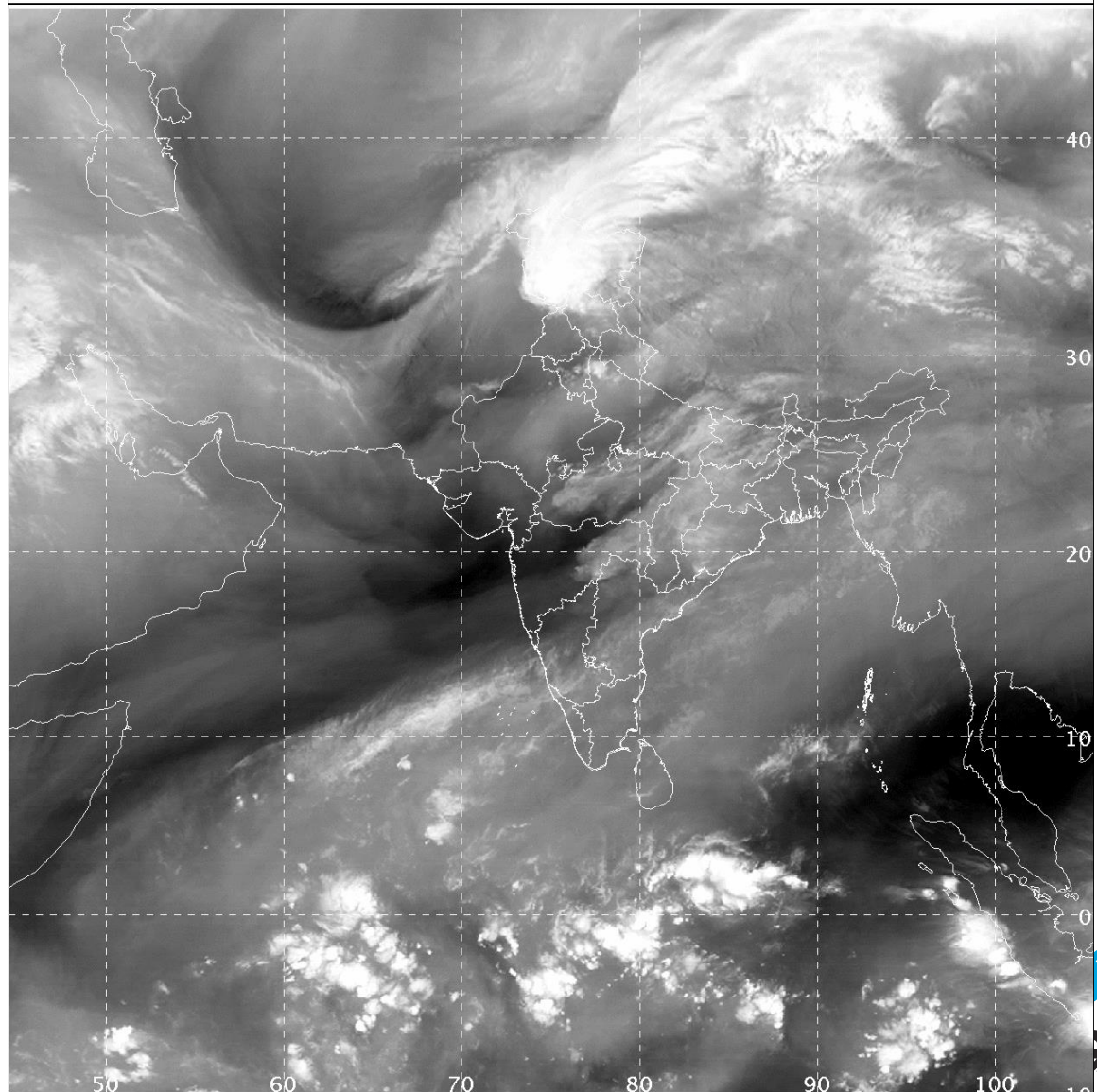




SAT :INSAT-3D IMG  
Water Vapor Count 6.8 um  
L1C SECTOR ASIA\_MER Mercator  
LINEAR Stretch: 1.0%

10-03-2014/00:00 GMT  
10-03-2014/05:30 IST

Animation of W.D.  
(10-12 MARCH, 2014)  
observed  
From INSAT-3D(WV band)

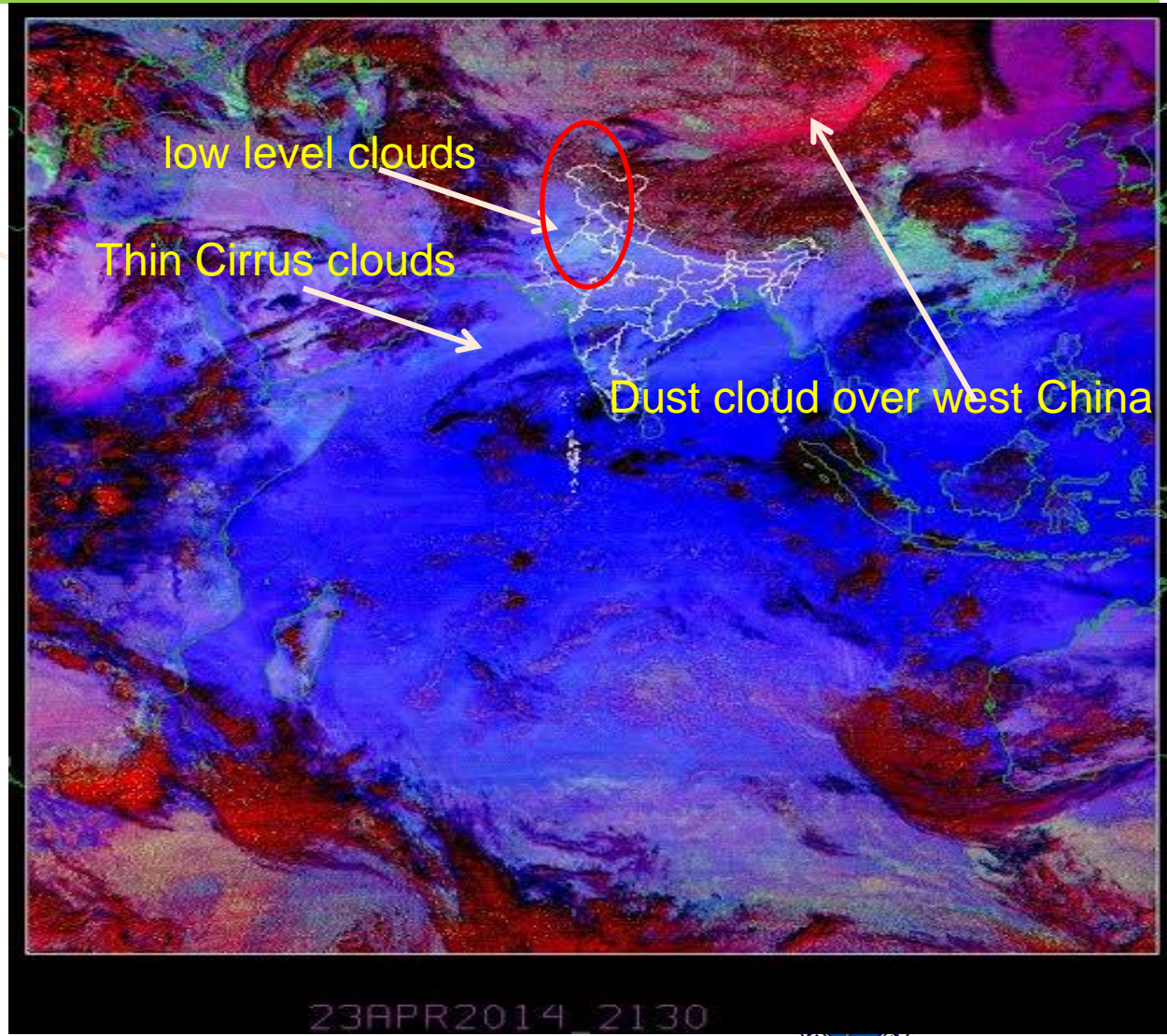






## INSAT-3D-Night Time Micro Physics-RGB 23 APR2014 2130 UTC

It is designed and tuned to monitor the evolution of night-time fog / low stratus. Other (secondary) applications are the detection of fires, low-level moisture boundaries and cloud classification in general. It should be noted that as the product is tuned for night-time conditions, its use during day-time is very limited. The Fog / Low Clouds RGB is composed from data from a combination of the Imager MIR3.9, IR10.8 and IR12.0 channels



Beam	Channel	Range	Gamma
Red	IR12.0 - IR10.8 (TIR2-TIR1)	-4 ... +2 K	1.0
Green	IR10.8 - IR3.9 (TIR1-MIR)	-4 to 6 K	1.0
Blue	IR10.8(TIR1)	+243 ... +293 K	1.0





# Geophysical parameters from Imager

Parameter Retrieval (PR) and Meteorological maps from INSAT Data Geo-Physical parameters are retrieved with INSAT-3D Meteorological data on an operational basis in Near Real time and Meteorological Image data Products generated & disseminated automatically.

Geo-physical products gets generated as soon as Level-1 processing is over. All geophysical parameters by using Level-1 data as input along with dynamic forecast data, climatological data, DEM and few static inputs.

No.	Parameter	Input Channels/Data
1	Cloud Mask (CM)	MIR, TIR-1, TIR-2
2	Outgoing Longwave Radiation (OLR)	WV, TIR-1, TIR -2
3	Quantitative Precipitation Estimation (QPE) GPI, IMRSA and HE	TIR-1, TIR- 2
4	Sea Surface Temperature (SST)	SWIR, MIR, TIR – 1, TIR –2
5	Snow Cover	VIS, SWIR, TIR – 1, TIR –2
6	Fire	MIR , TIR -1
7	Smoke	VIS, MIR, TIR –1, TIR –2
8	Aerosol	VIS, TIR –1, TIR -2
9	Cloud Motion Wind Vector (CMV)	VIS, TIR-1, TIR –2
10	Water Vapor Wind Vector (WVWV)	WV, TIR-1,TIR –2
11	Upper Tropospheric Humidity (UTH)	WV, TIR-1, TIR –2
12	Fog	SWIR, MIR, TIR-1, TIR-2



## INSAT-3D Imager Products types and formats

The various types of data generated by the Data Products System in different formats are:

- LEVEL - 0 (Raw) – for internal use and archival
- LEVEL - 1 (Full Globe, Sector)
- LEVEL - 2 (Geo-physical)
- LEVEL - 3 (Binned Geo-Physical)

S.No.	Data Product	Processing Level	Code	Format	Remarks
<b>Standard Products</b>					
1	Standard Product Full Disk	L1B	STD	HDF	Per Pixel Lat & Lon as viewed by Satellite
2	Standard Product Full Disk Fixed Grid	L1C	STD	HDF	Projected on Fixed Grid
3	Standard Sector Product	L1C	Sector mnemonic	HDF	Map Projected



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

### Geo-Physical Parameters

1	Outgoing long wave radiations	L2B	OLR	HDF	Per Pixel
2	Rainfall using Hydro Estimator	L2B	HEM	HDF	Per Pixel
3	FOG	L2C	FOG	HDF	Per Pixel
4	SNOW	L2C	SNW	HDF	Per Pixel
5	Cloud Mask	L2B	CMK	HDF	Per Pixel
6	Upper Troposphere Humidity	L2B	UTH	HDF	PerPixel
7	Sea Surface Temperature	L2B	SST	HDF	PerPixel

### Geo-Physical Parameters (Point)

1	FIRE	L2P	FIR	KML	Point
2	SMOKE	L2P	SMK	KML	Point
3	Atmospheric Motion Vectors	L2P	AMV	HDF	VIS, TIR, WV, MIR (Point)

### Geo-Physical Parameters (Gridded)

1	INSAT Multi-Spectral Rainfall Algorithm (IMSRA)	L2G	IMR	HDF	0.1 deg x 0.1 deg
2	Quantitative Precipitation Estimation	L2G	QPE	HDF	1 deg x 1 deg
3	Aerosol Optical Depth	L2G	AOD	HDF	0.1 deg x 0.1 deg

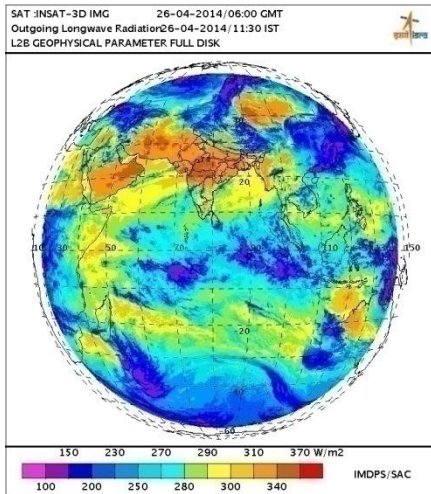


## INSAT-3D Imager Products types and formats cont.

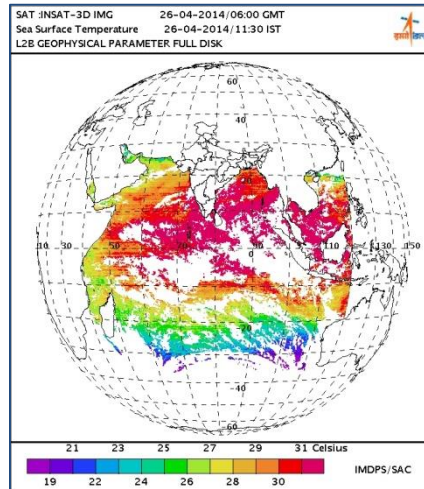
S.No	Data Product	Processing Level	Code	Format	Remarks
<b>Standard Products</b>					
<b>Binned Geo-Physical Parameters (Temporally Binned)</b>					
1	Outgoing long wave radiations	L3B	OLR	HDF	Daily, Weekly, Monthly and Yearly Per Pixel
2	Rainfall using Hydro Estimator	L3B	HEM	HDF	Daily, Weekly, Monthly and Yearly (Per Pixel)
3	Sea Surface Temperature	L3G	SST	HDF	Daily, Weekly, Monthly and Yearly 0.5 deg X 0.5 deg
4	Upper Troposphere Humidity	L3G	UTH	HDF	Daily, Weekly, Monthly and Yearly, 0.1 deg x 0.1 deg
5	INSAT Multi-Spectral Rainfall Algorithm (IMSRA)	L3G	IMR	HDF	Daily, Weekly, Monthly and Yearly 0.1 deg x 0.1 deg
6	Quantitative Precipitation Index	L3G	QPI	HDF	Daily, Weekly, Monthly and Yearly (1 deg x 1 deg)



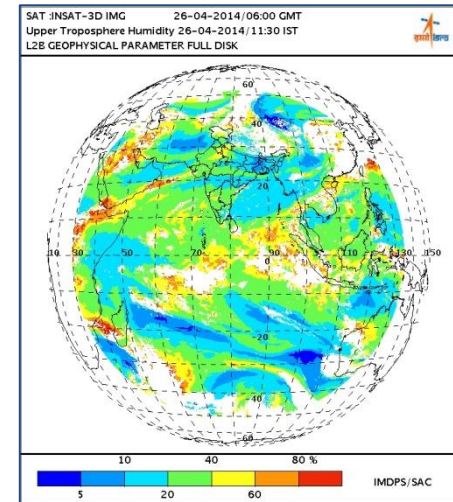
## INSAT-3D Imager Geo-Physical Parameters (L2) viewed on 27 APR 2014 at 0600



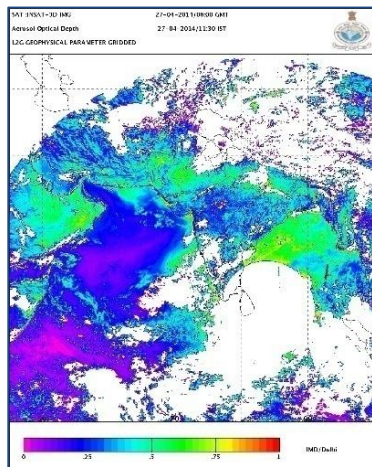
### OLR



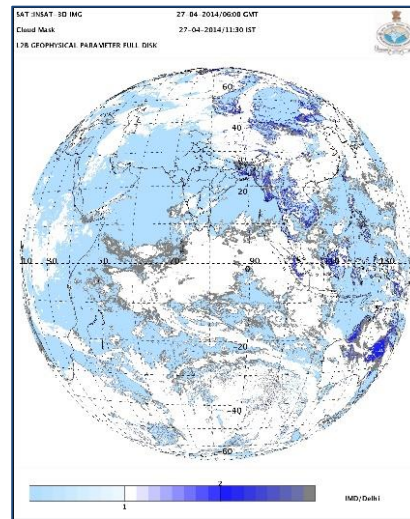
### SST



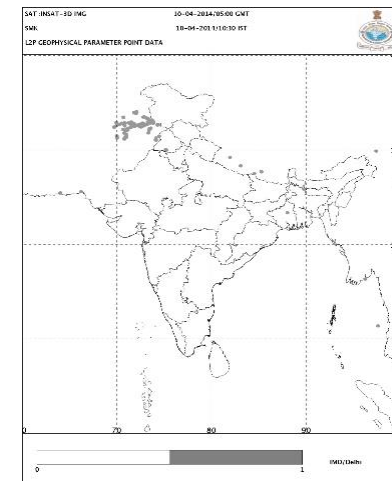
### UTH



### AOD



### CMK

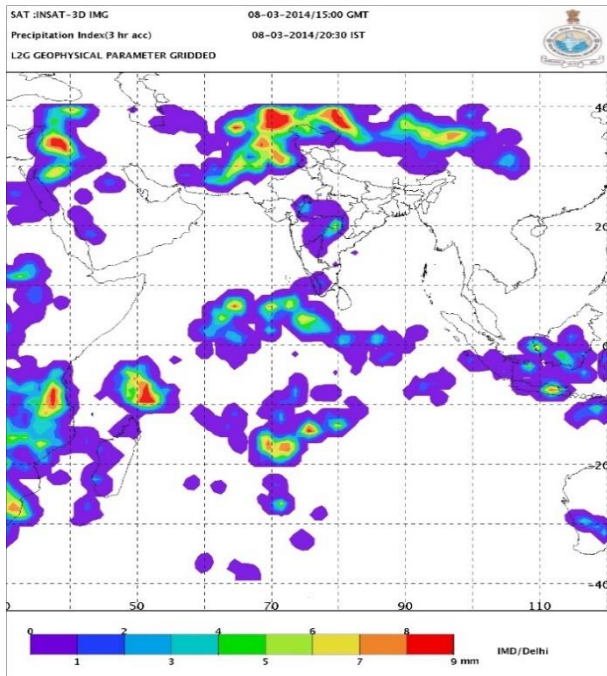


### Smoke

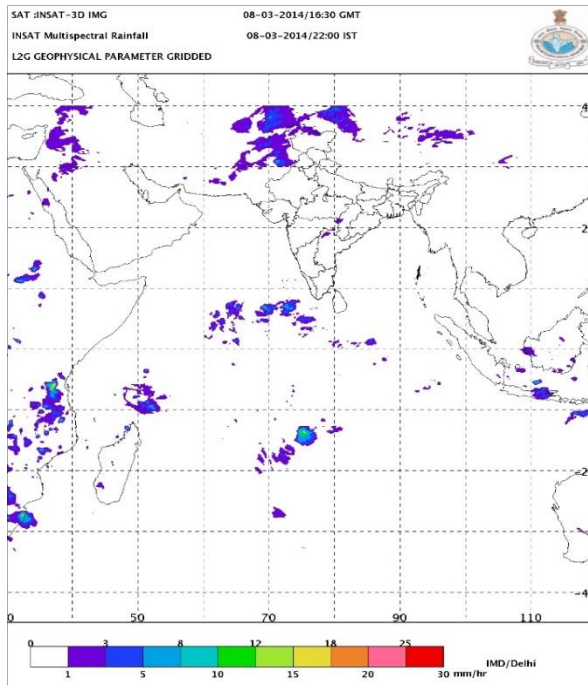




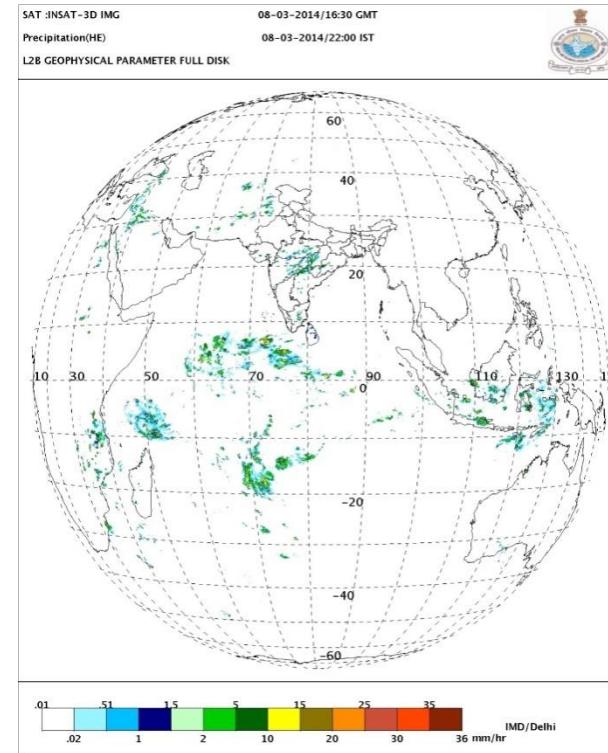
## INSAT-3D Imager Geo-Physical Parameters R/F(L2) viewed on 08 MAY 2014 at 1500



PI



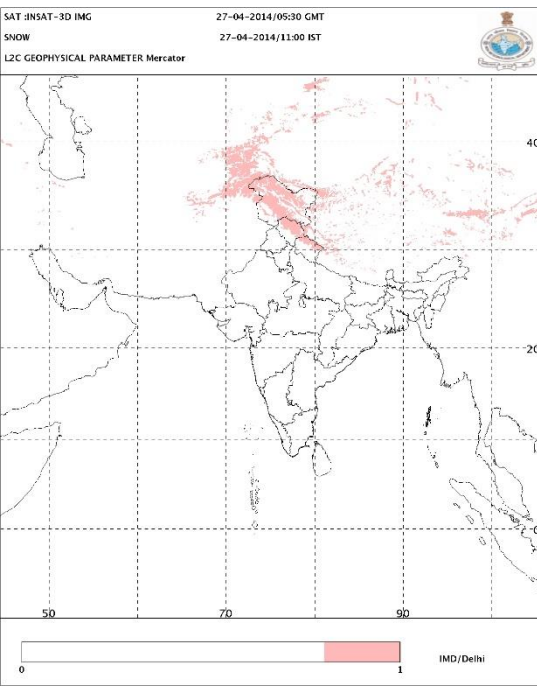
IMSRA



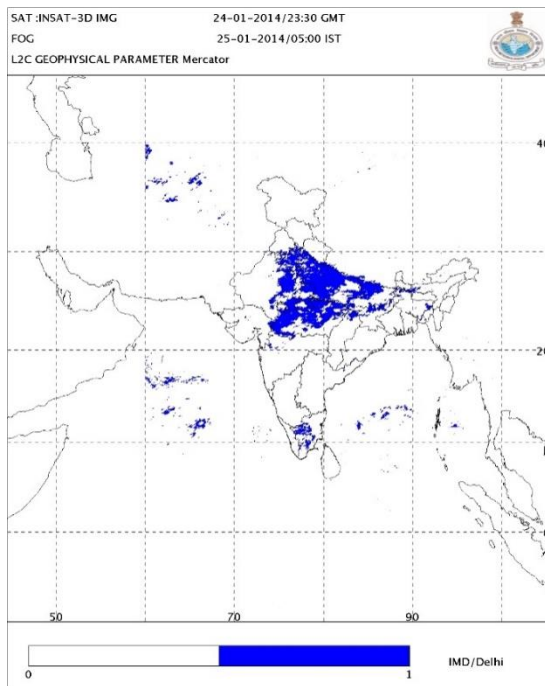
HE



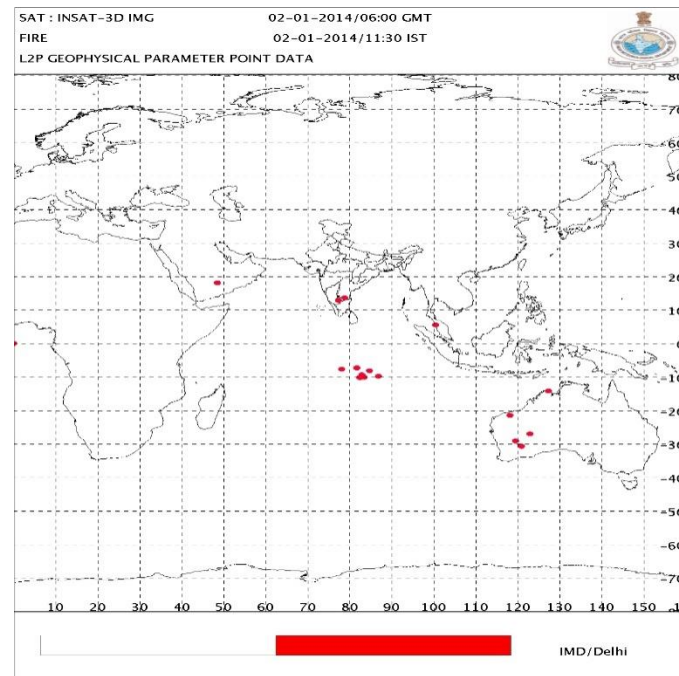
## INSAT-3D Imager Geo-Physical Parameters (L2)



Snow



FOG

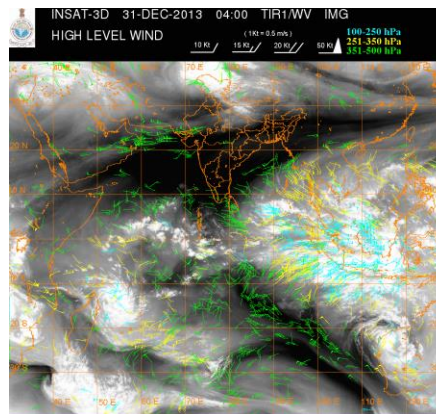
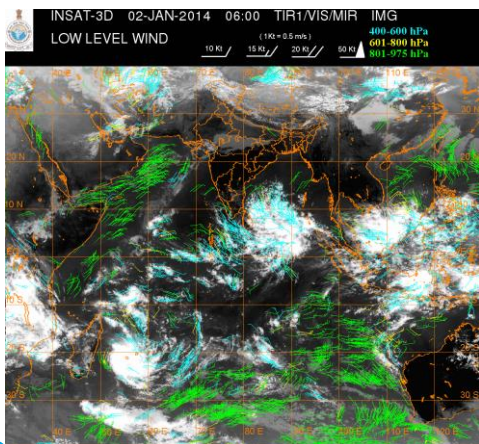
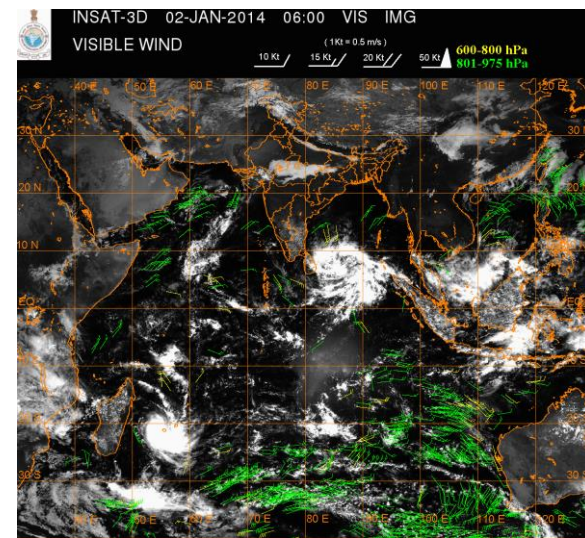
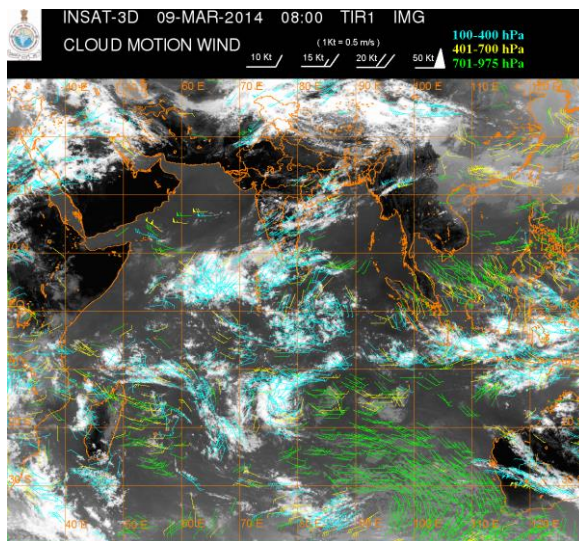
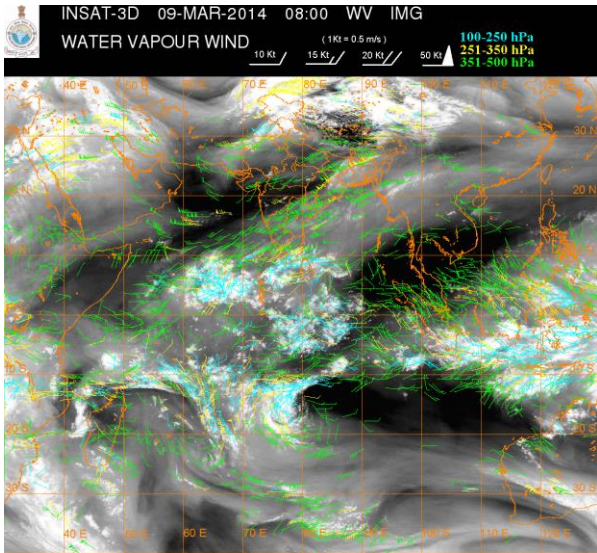


Fire





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



**Coordination Group for Meteorological Satellites**

**IMD**





# Accuracies and Sensitivity of INSAT-3D Imager Geophysical Parameters

Product	Specified Accuracy	Achieved Accuracy
OLR	4%	3% (50-Km, Daily) 4% Inst.
UTH	30% for Inst. Pixel level	30%
SST	1 K (Day) < 1 K (Night)	0.5-1.0 K
Fog	5% of foggy area	4% of foggy area
PI Rain (1-Deg)	20% of observed	25% of observed
IMSRA Rain (0.1 Deg)	35% of observed	25% of observed
HE Rain (pixel level, 30-min)	35% of observed	25% of observed
Snow Cover	10%	4% with field data. 11% with AWIFS



## Accuracies and Sensitivity of INSAT-3D Imager Geophysical Parameters

Product	Specified Accuracy	Achieved Accuracy
AOD	10%	9%
Smoke	Not Specified	17% of detected area
Cloud Motion Winds (TIR1)	6.0 m/s (Mid-high level) 4.5 m/s (Low level)	6.0 m/s (upper level) 5.6 m/s (mid-level) 4.5 m/s (low level)
Water Vapour Winds	7 m/s	6.5 m/s





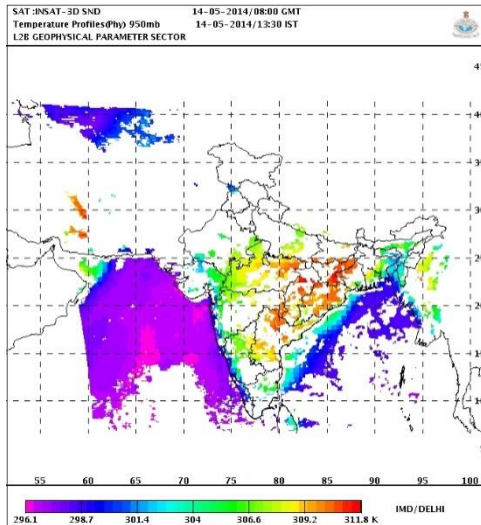
## Geophysical parameters from Sounder

S.No.	Parameter	Data Input
1.	Temperature, Humidity profile and Ozone	Brightness temperatures for 18 Sounder Channel and grey count for channel 19
2.	Geo-potential Height	Sounder retrieved temperature and humidity profiles at 40 pressure levels
3.	Layer Perceptible Water	Retrieved humidity at standard pressure levels
4.	Total Perceptible Water	Retrieved humidity at standard pressure levels
5.	Lifted Index	Sounder retrieved temperature and humidity profiles at standard pressure levels
6.	Dry Microburst Index	Sounder retrieved temperature and humidity profiles at standard pressure levels
7.	Maximum Vertical Theta-E Differential	Sounder retrieved temperature and humidity profiles at standard pressure levels
8.	Wind Index	Geo- potential Height and retrieved temperature and humidity profiles at standard pressure levels

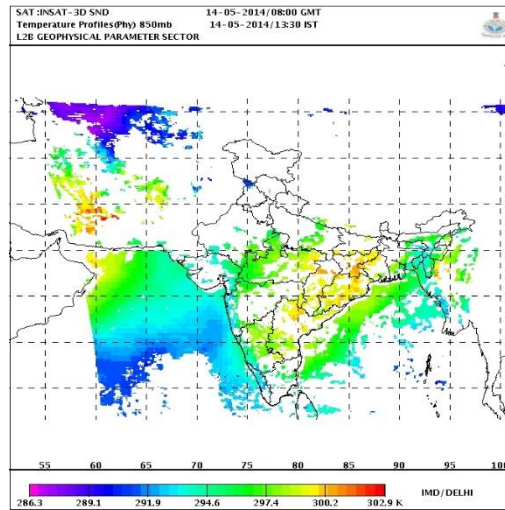


## Temperature Profile (K) 14 MAY 2014 0800 UTC

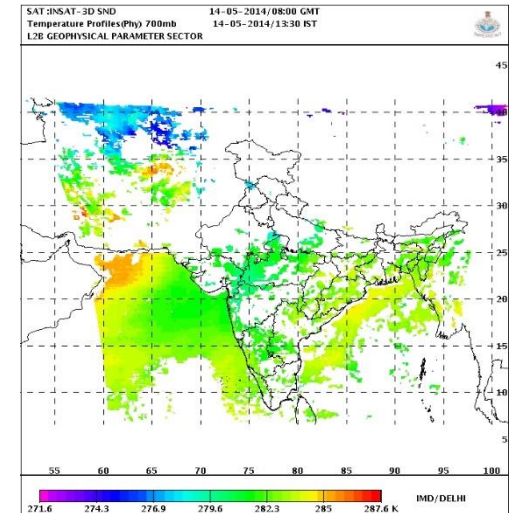
### 950 hPa



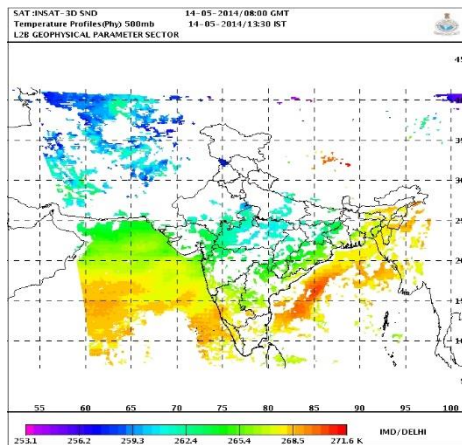
### 850 hPa



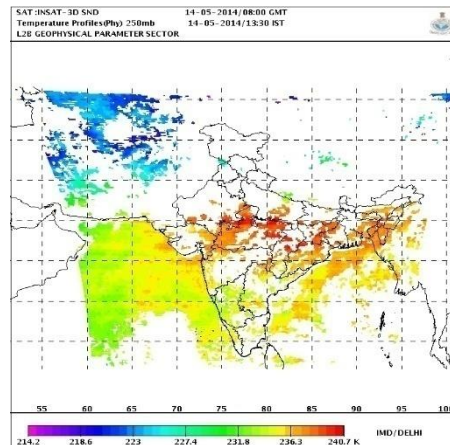
### 700 hPa



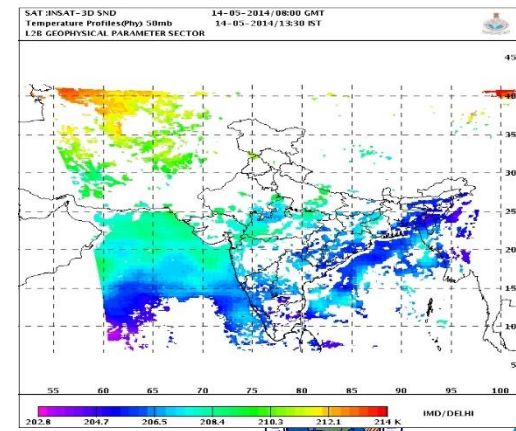
### 500 hPa



### 250 hPa



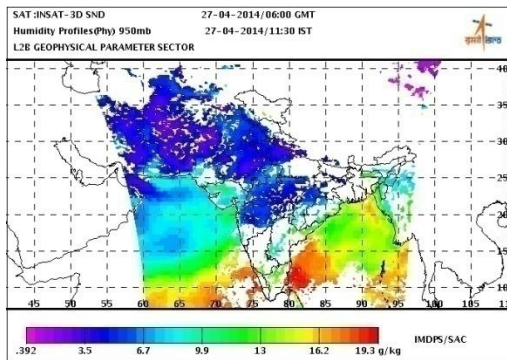
### 50 hPa



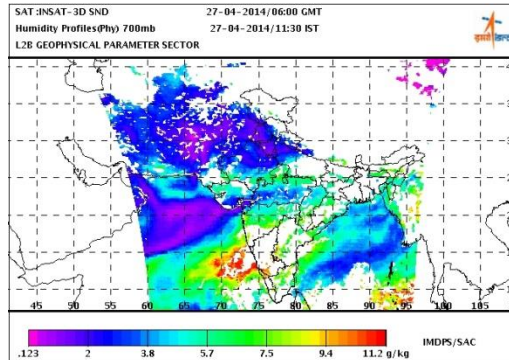


## Humidity Profile (g/kg) (27 APR 2014 0600 UTC)

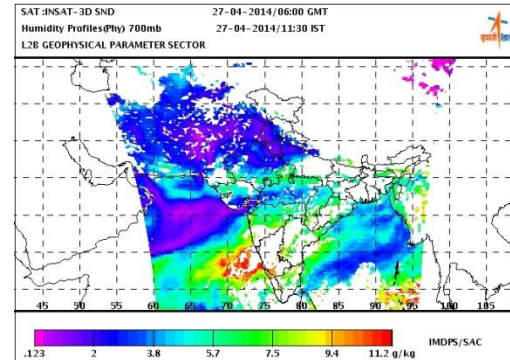
### 950 hPa



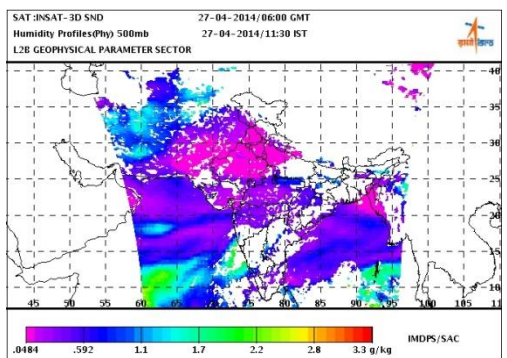
### 850 hPa



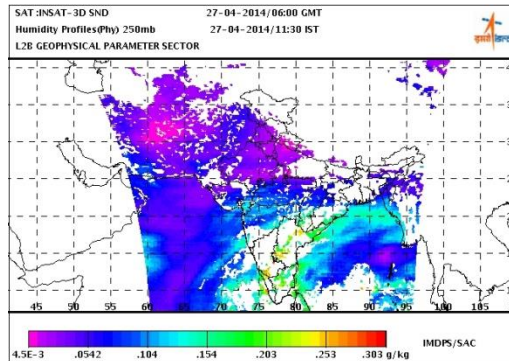
### 700 hPa



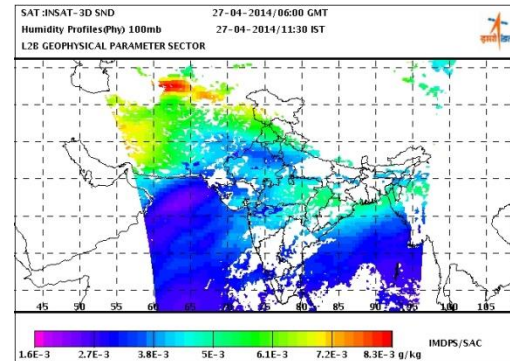
### 500 hPa



### 250 hPa



### 100 hPa

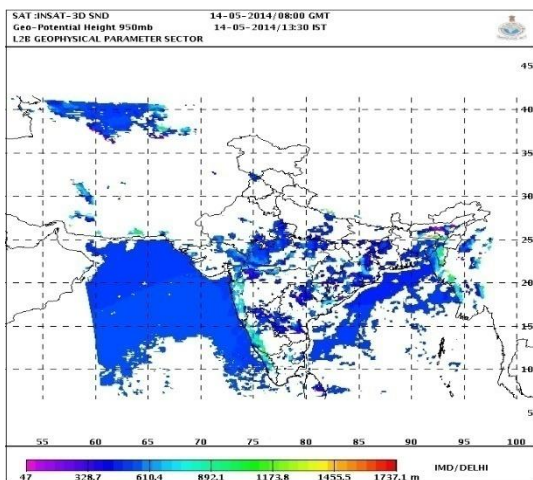




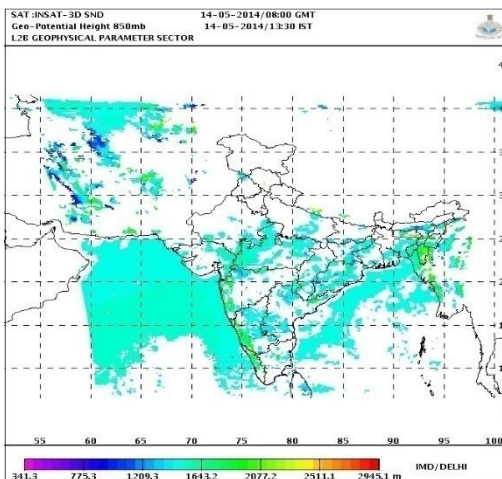


## Geo Potential height Profile (M) (14 MAY 2014 0800 UTC)

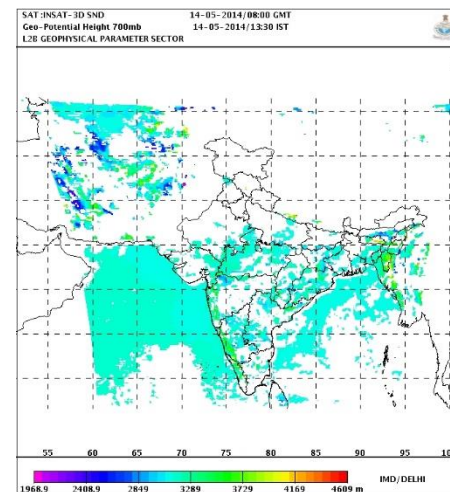
### 950 hPa



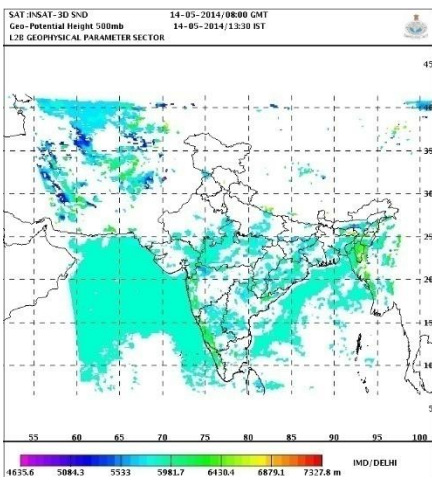
### 850 hPa



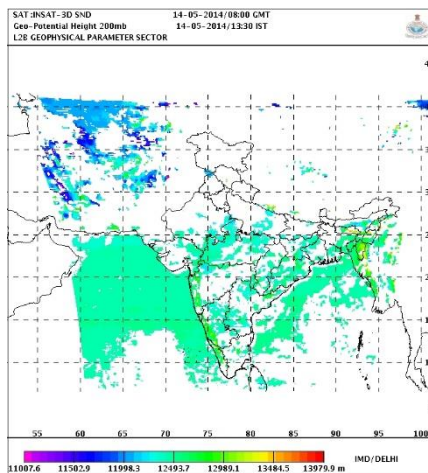
### 700 hPa



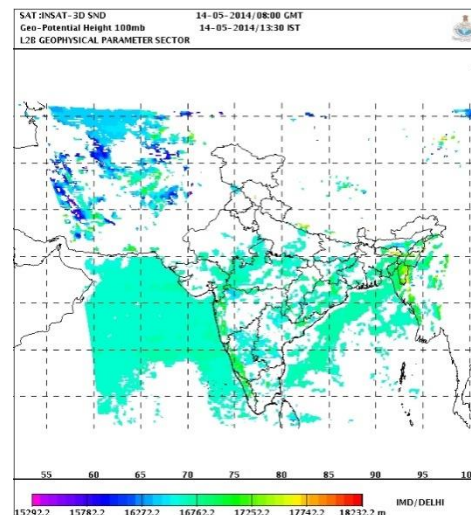
### 500 hPa



### 200 hPa



### 100 hPa

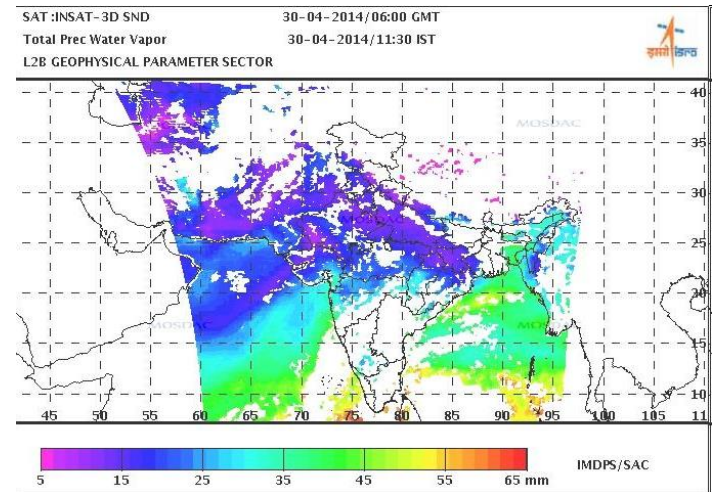
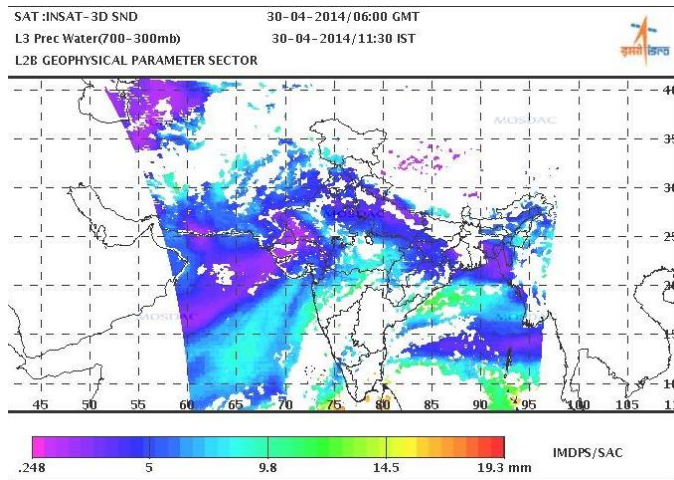
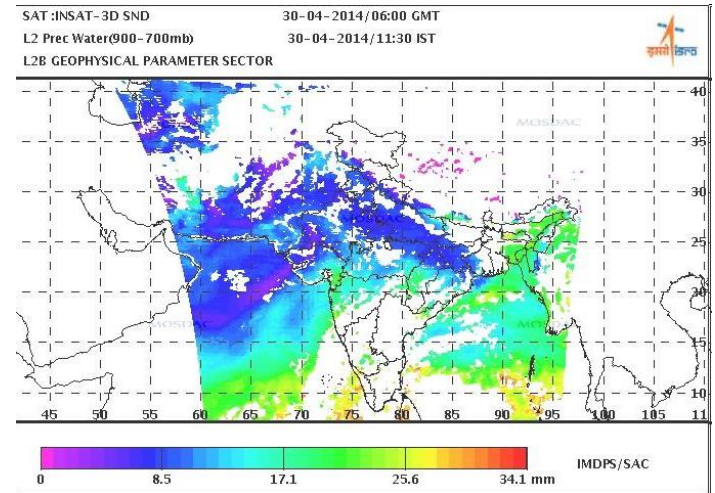
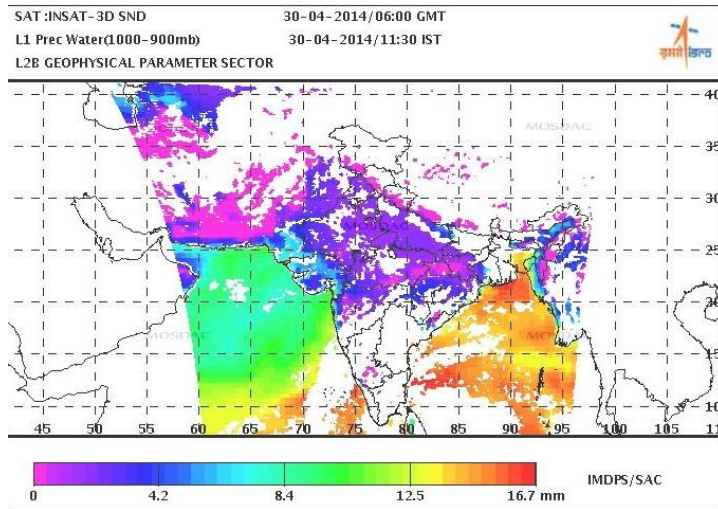






# Coordination Group for Meteorological Satellites - CGMS

Layer and total precipitable water; Layers (1000-900, 900-700, 700-300hpa) as viewed on 30 APR 2014 at 0600 UTC



Coordination Group for  
Meteorological Satellites

IMD

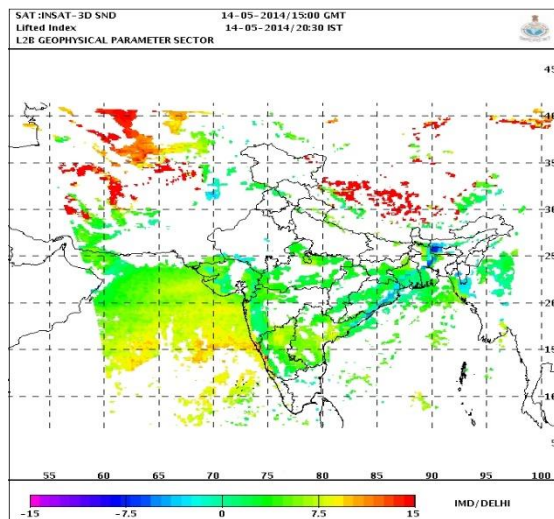


CGMS

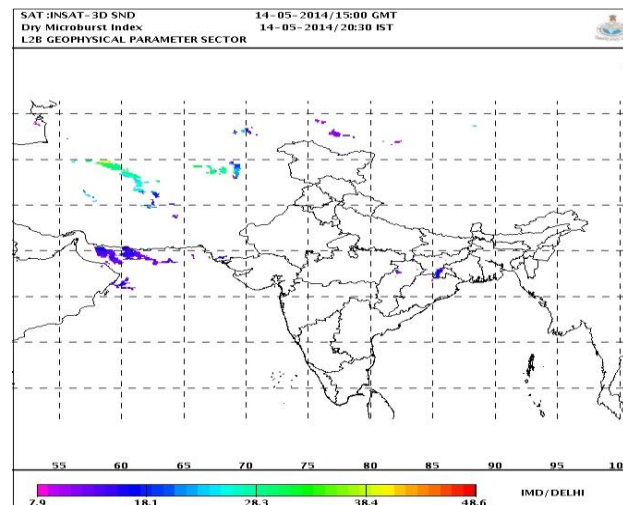


## Sounder Derived Products(14 MAY 2014 1500 UTC)

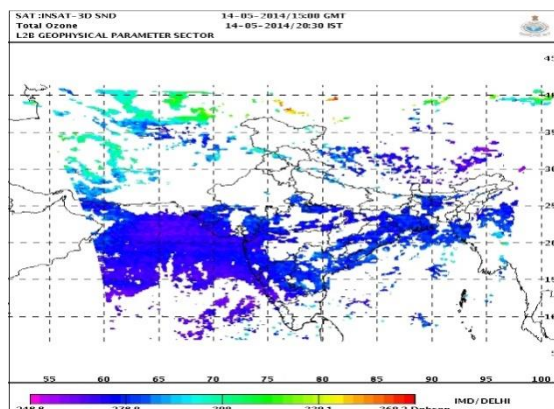
### Lifted Index



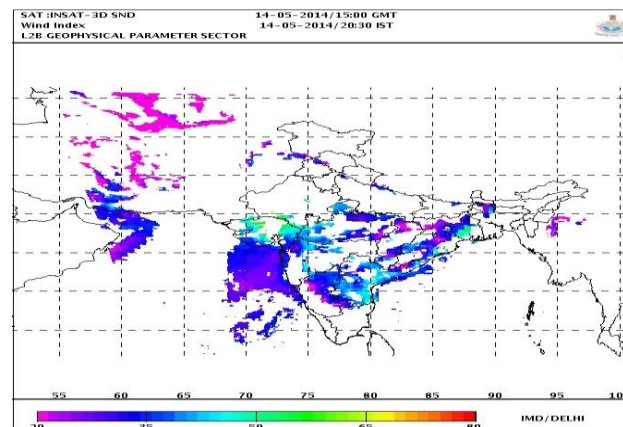
### Dry Microburst Index



### Total Ozone (Dobson)



### Wind Index





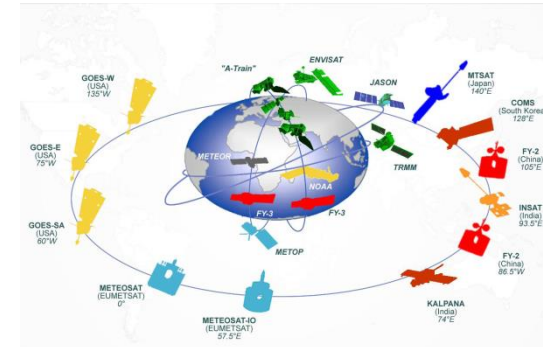
## Accuracies and Sensitivity of INSAT-3D Sounder Geophysical Parameters

Product	Specified Accuracy	Achieved Accuracy
T-Profile	1-2 K in troposphere	1-1.5 K in troposphere
Humidity Profile	20-30%	< 10% (surf-850) 10-25% (850-200 hPa) 15-25% (< 200 hPa)
Total Ozone FIRE	5%	Validation Pending



## To be considered by CGMS:

- Replacement of Meteosat-7 by MSG/MTG by EUMETSAT to maintain continuity in services over the region (Indian Ocean region)
- .
- .





## Dedication of INSAT-3D Meteorological Data Processing System (IMDPS) to Nation at National Satellite Meteorological Center (NCMC) at IMD, New Delhi.

By  
**Shri. S. Jaipal Reddy**  
Honorable Minister of Science & Technology, and Earth Sciences  
On 15<sup>th</sup> Jan 2014.

