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INTER-PROGRAMME EXPERT TEAM ON SATELLITE UTILIZATION AND  
PRODUCTS

ITEM: 9

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## **VALIDATION OF INSAT-3D DERIVED RAINFALL**

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### **Summary and Purpose of Document**

India has launched the INSAT-3D satellite on 26<sup>th</sup> July 2013 exclusively for meteorological purposes, having six-channel imager and nineteen-channel sounder system located at 82.0°E. Imagery and Products from the satellite are being operationally derived since January 15, 2014. Improved resolution of imageries & products of INSAT-3D are useful in improving monitoring of different weather systems and forecasting. There are three different rain estimation algorithms to measure the rainfall rate through satellite i.e. Hydro-estimator (H-E), INSAT Multispectral Rainfall Algorithm (IMSRA), GOES Precipitation Index (GPI).

The purpose of the document to inform about the different rainfall estimation algorithms of INSAT-3D and their validation to user community.

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### **ACTION PROPOSED**

The second session is invited to:

- (a) Give comments on the data and products from INSAT 3D;
- (b) Suggest further improvement of the data and products.

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**Appendices:** A. Characteristics of INSAT-3D Imager and Sounder, and derived products  
B.

## DISCUSSION

1. The Satellite Meteorology Division has been set up in India Meteorological Department (IMD) in 1982 with mandate to provide satellite-based products to the forecasters. At present India has three geo-stationary satellites for meteorological purposes:
  - (i) METSAT (Kalpana-1) launched on 12 September 2002
  - (ii) INSAT-3A launched on 10 April 2003.
  - (iii) INSAT-3D launched on 26 July 2013.

Whereas Kalpana -1 & INSAT-3A are having three imager channels, INSAT-3D has six imager channels with improved resolution, and nineteen sounder channels. The details of Imager & sounder channels are given in Appendix A.

2. Six-channels are Visible (VIS), Shortwave Infrared (SWIR), Medium wave Infrared (MIR), water vapour (WV), Thermal Infrared (TIR1, TIR2) imagers are being derived on half hourly basis. Besides these, the following geo-physical parameters are also being derived from INSAT-3D satellite (list of geophysical parameters derived from INSAT-3D is given in Appendix A).
  3. There are three different satellite derived rainfall products which are operational in IMD from INSAT-3D
    - Hydro-estimator (Per Pixel Latitude & Longitude as viewed by Satellite 4kmX4km)
    - INSAT Multispectral Rainfall (Gridded 0.1°X0.1°)
    - GOES Precipitation Index (Gridded 0.25°X0.25°)
  4. The Hydro-Estimator is based on similar operational method at NOAA/STAR, H-E uses INSAT- 3D TIR-1 (10.8  $\mu$ m) brightness temperature as input along with NWP model parameter to generate rainfall rate. IMSRA uses TIR-1 and WV channel of INSAT-3D and Satellite Microwave Rainfall (TRMM/PR). GPI generates Quantitative Precipitation Estimates (QPE) for every three hourly by using INSAT-3D TIR-1 and WV channels of INSAT-3D.
  5. The validation of rainfall products are done by comparing the rainfall product (converted into grid data of 0.25°X0.25°) with the actual IMD grid data of same resolution. If the data is in pixel format it is converted into 0.25°X0.25° grid (e.g. H-E). The validation is done for the period of July 2015 to September 2015 for H-E and June to September 2015 for IMSRA daily as well as monthly for better understanding of the performance of the rainfall estimation algorithms. Validation is also done for the season at every grid point (an example attached in Appendix B). For validation, only land observation over India are taken.
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## Appendix A

## INSAT-3D IMAGER

Spectral Channels	Spectral Range ( $\mu\text{m}$ )	Resolution (km)	Quantization bits
VIS	0.55 – 0.75	1	10
SWIR	1.55-1.70	1	10
MIR	3.80-4.00	4	10
WV	6.50-7.10	8	10
TIR 1	10.3-11.3	4	10
TIR 2	11.5 – 12.5	4	10

## INSAT-3D Sounder

Band No	Center wavelength $\mu\text{m}$ ( $\text{cm}^{-1}$ )	Bandwidth $\mu\text{m}$ ( $\text{cm}^{-1}$ )	NEDT at 300 K (typical) K	Principal absorbing constituents
1	14.71 (680)	0.281 (13)	1.5	CO <sub>2</sub> band
2	14.37 (696)	0.268 (13)	1	CO <sub>2</sub> band
3	14.06 (711)	0.256 (13)	0.5	CO <sub>2</sub> band
4	13.96 (733)	0.298 (16)	0.5	CO <sub>2</sub> band
5	13.37 (749)	0.286 (16)	0.5	CO <sub>2</sub> band
6	12.66 (790)	0.481 (30)	0.3	Water vapor
7	12.02 (832)	0.723 (50)	0.15	Water vapor
8	11.03 (907)	0.608 (50)	0.15	window
9	9.71 (1030)	0.235 (25)	0.2	ozone
10	7.43 (1425)	0.304 (55)	0.2	Water vapor
11	7.02 (1425)	0.394 (80)	0.2	Water vapor
12	6.51 (1535)	0.255 (60)	0.2	Water vapor
13	4.57 (2188)	0.048 (23)	0.2	N <sub>2</sub> O
14	4.52 (2210)	0.047 (23)	0.15	N <sub>2</sub> O
15	4.45 (2245)	0.045 (23)	0.15	CO <sub>2</sub>
16	4.13 (2420)	0.0683 (40)	0.15	CO <sub>2</sub>
17	3.98 (2513)	0.0683 (40)	0.15	window
18	3.74 (2671)	0.140 (100)	0.15	window
19	0.695 (14367) 0.05 (1000) (0.67-0.72)		0.1% albedo	VIS

Sr. No	Geophysical Parameter Name	SENSOR	Level	Mnemonics
<b>Per Pixel Products (IMAGER)</b>				
1.	Outgoing Longwave Radiation	IMAGER	L2B	OLR
2.	Hydro Estimator derived Precipitation	IMAGER	L2B	HEM
3.	Cloud Mask	IMAGER	L2B	CMK
4.	Sea Surface Temperature	IMAGER	L2B	SST
5.	Upper Troposphere Humidity	IMAGER	L2B	UTH
<b>Gridded Geophysical Parameters (IMAGER)</b>				
6.	Quantitative Precipitation Estimate (IMR Method)	IMAGER	L2G	IMR
7.	Quantitative Precipitation Estimate (GPI Method)	IMAGER	L2G	GPI
8.	Aerosol Optical Depth	IMAGER	L2G	AOD
<b>Point Geophysical Parameters (IMAGER)</b>				
9.	Wind Vectors	IMAGER	L2P	VIS/IR/WV/MIR
10.	Smoke	IMAGER	L2P	SMK
11.	Fire	IMAGER	L2P	FIR
<b>Map Projected Geophysical Parameters (IMAGER)</b>				
12.	Fog	IMAGER	L2C	FOG
13.	Snow Cover	IMAGER	L2C	SNW
<b>Per Pixel Products (SOUNDER)</b>				
14.	Atmospheric Profiles and Derived Parameters	SOUNDER	L2B	SA1/SB1 (Sector Acquired)

## Appendix B

### Example for validation of INSAT-3D derived precipitation using ground-based rainfall gauges

Correlation Coefficient(R) IMD vs IMSRA JJAS-2015

