CGMS-XXX WP-IND-02
Prepared by India
Agenda Item: B.2
Discussed in Plenary

Current status of INSAT and METSAT satellites for meteorological applications

This paper describes the technical details and status of currently operational satellites of INSAT series. The last satellite of INSAT-1 series (INSAT-1D) was deactivated on 14 May 2002 after providing useful services for about 12 years. A new dedicated meteorological satellite (METSAT) has been successfully commissioned recently. The last satellite of INSAT-2 series (INSAT-2E) is also providing useful cloud imagery data in 3-channels at 1 km resolution. The other communication based operational services being derived from INSAT series of satellites are also described in this paper, along with the activities of India Meteorological Dept. related to training in satellite meteorology. Details of bilateral collaboration programme with USA for exchange of INSAT data are also given.

Current status of INSAT and METSAT satellites for meteorological applications

1.1 Introduction

INSAT is an operational multipurpose satellite system catering to the needs of three different services, viz Television & Radio Broadcasting, Communications and Meteorology. The INSAT project is a joint venture of the Department of Telecommunications (DOT), the India Meteorological Department (IMD), Doordarshan and All India Radio (AIR). The responsibility for overall management and coordination of the INSAT system among the user agencies rests with the INSAT co-ordination committee (ICC).

The first satellite INSAT-1A of the INSAT-1 series was launched in April, 1982 and it ceased to function totally from 6 September 1982 as a result of major anomaly on the satellite. The second satellite (INSAT-1B) was launched on 30 August 1983 and it became operational on 15 October, 1983. It was the main operational satellite all through the 1980s and provided very good services during its entire mission life. It was deorbited in July,93. The third satellite of the series (INSAT-1C) was launched on 22 July 1988. Due to some technical problem it lost control on 22nd November, 1989 after which it was not available for operational services. The last satellite of INSAT-1 series (INSAT-1D) was launched on 12 June,1990 and became operational on 17 July, 90. After having provided services for nearly 12 years, INSAT-1D reached its end of life on 13th May, 2002.

The 2nd generation of INSAT satellites (INSAT-2 series) were started from July, 1992 with the successful launch of the first satellite of the series (INSAT-2A) on 10th July 92. The 2nd satellite of INSAT-2 programme i.e. (INSAT-2B) was also launched successfully on 22 July, 1993. All INSAT satellites are three-axis body stabilised spacecrafts. The last satellite of INSAT-2 series i.e., INSAT-2E was launched successfully on 3 April,1999. It is operational from May 1999. It has a new payload, called Charged Coupled Device (CCD) camera capable of taking 1 km resolution images in 3 bands. The meteorological imaging capability has also been upgraded on this satellite, as compared to its predecessors, by providing a water vapor channel with 8 km resolution in the VHRR, the imaging instrument of the satellite. However on account of some limitations, the VHRR data is of very limited use. A new satellite METSAT has been launched on 12th Sept.,2002 and has been declared operational with effect from 25th Sept.,2002. This satellite has VHRR (Vis, IR & Water vapour) and Data Relay Transponder (DRT) on board and exclusively dedicated to Meteorological services of the country.

1.2 Current operational status

The imaging mission is working satisfactorily with METSAT satellite and it continues to be used operationally from 74^{o}E longitude position. High resolution (1km) images in 3 channels are also available operationally from CCD camera onboard INSAT-2E. The activities like image processing, derivation of meteorological products, data archival and dissemination of products to field stations for operational use are being done on a operational routine basis.

VHRR images are normally received at three- hourly intervals. More frequent images are taken for monitoring the development of special weather phenomena as and when the situation demands. CCD images from 2E are also being taken every three hours for operational use during daytime. More frequent images are also taken if situation demands. However, due to some anomaly in scan mechanism VHRR onboard INSAT-2E is not currently available for operational use. For the derivation of CMVs half hourly triplets at 00 UTC, 06 UTC and 12 UTC are also received from METSAT and data processed. The METSAT derived CMVs shall be available on GTS soon.

Appendix-A gives details of present and past satellites of INSAT-1 and INSAT-2 series.

1.3 Characteristics of VHRR payload

THE VHRR onboard METSAT includes:

(a) A visible channel operating in the spectral wavelength of 0.55-0.75 microns.

(b) Infrared (IR) channel operating in 10.5-12.5 microns.

(c) Water Vapour channel operating at 6.7 microns.

Main differences between INSAT-1, INSAT-2 and METSAT are in VHRR resolution, scan time, data rate and frequency of transmission.

	INSAT-1D		INSAT-2B		METSAT		
Parameter	Visible	IR	Visible	IR	Visible	IR	WV
Spatial Resolution in Km	2.75	11	2.0	8.0	2.0	8.0	8.0
Scanning lines	4548	1137	6240	1560	6240	1560	1560
Quantization level	1024	1024	1024	1024	1024	1024	1024
Field of view (μr)	76.8	307	56	224	56	224	224
Detectors	Silicon photodiodes	HgCdTe	Si	HgCdTe	Si	HgCdTe	
Location	deorbited		111.5 Deg E		74 deg E		
Modes of Operation	Full Frame 20 X 20 Sector Scan 20 E-W X 5 N		FF 20 X 20 Normal Scan 20 EW X 14 NS Sector Scan 20 EW X 5 NS		FF 20 X 20 Normal Scan 20 EW X 14 NS Sector Scan 20 EW X 5 NS		

INSAT-2E is located at 83 deg E longitude and provides imaging capability at 1 km resolution in 3 channels of visible, Near IR and Short-wave infrared. INSAT data are being processed at IMD facility "INSAT Meteorological Data Processing System (IMDPS)" located in IMD's campus at Lodi Road, New Delhi.

The processing system is configured around eight VAX Computers in a clustered network, with a number of other peripheral devices attached. The processed data and products are stored on a 4 GB sized data base. Users can access the data base in real-time through four work stations connected to the system. Imagery data of main synoptic hours are being archived as hard copies. Processed 8 bit imagery data are also archived on magnetic tapes at 6250 BPI for later use in R&D related works. Quantitative products such as OLR, QPE & SSTs are also archived on magnetic tapes. Photographic recorders of three different types are also connected to the system for generation of B& W and colour photographic pictures in real- time for the main users.

1.4 METEOROLOGICAL DATA DISSEMINATION (MDD)

The processing system is also being used for generating analogue type of cloud imagery data which are transmitted through INSAT-2B to field stations using S-band broadcast capability of the satellite along with other conventional meteorological data and FAX charts. This scheme is called Meteorological Data Dissemination (MDD).

There are about 90 MDD receiving stations in the country being operated by different agencies. Two MDD receiving stations are also operating in neighbouring countries at Sri Lanka and Male under bi-lateral agreement. In general, the processed images are sent to these stations every three hours, and every hour during cyclone periods. These stations are receiving direct broadcasts of cloud imagery, weather facsimile charts and meteorological data on an operational basis.

The frequency of transmission from ground to satellite (Uplink) is 5899.225 MHz and downlink is at 2599.225 MHz.

1.5 DATA COLLECTION PLATFROM (DCP)

The Data Relay transponder (DRT) on board INSAT is being used for collection of meteorological, hydrological and oceanographic data from remote and inaccessible areas. The DCP data are received through METSAT. IMD has installed 100 Data Collection Platforms (DCPs). Other agencies have also installed about 70 DCP stations which are operational with METSAT.

Characteristics of DCPs.

Frequency of transmission	402.75 MHz (uplink)
Downlink frequency	4504.1 MHz
Bit rate	4.8 kbps
EIRP (uplink)	16.5 dbw
Mode of transmission	Burst mode

Burst length	87 milliseconds
Number of sensor	10 (7 analog & 3 digital)
Number of bits in one frame	422 bits

1.6 CYCLONE WARNING DISSEMINATION SYSTEM (CWDS)

For quick dissemination of warnings against impending disaster from approaching cyclones, specially designed receivers have been installed by IMD within the vulnerable coastal areas for direct transmission of warnings to the officials and people in general using broadcast capability of INSAT satellite. IMD's Area Cyclone Warning Centres (ACWC) generate these special warning bulletins and transmit them every hour in local languages to the affected areas. 250 such receiver have been installed by IMD in the field areas. CWDS has proved very effective system of warning people during the cyclone affecting the coastal areas. For this service the frequency of transmission from ground to satellite (uplink) is 5859.225 MHZ and Downlink is at 2559.225 MHz.

1.7 TRAINING AND REASEARCH ACTIVITIES

IMD is providing training in satellite meteorology to Indian and foreign students under SAARC and other related programmes on a regular basis. The theory and practical classes are conducted by expert scientists. A new institute had been set up in 1998 at Ahmedabad (India) to teach Satellite Meteorology and other related subjects to national and foreign personnel. This institution is named as " Centre for Space Science and Technology Education for Asia and the Pacific (CSSTE-AP)" and is affiliated to the United Nations. IMD's experts are delivering lectures on satellite Meteorology in the Post Graduate training courses conducted periodically by this Institute.

IMD and other institutions namely, Space Applications Centre, Indian institute of Technology, National Centre for Medium Range Weather Forecasting (NCMRWF), Indian Institute of Tropical Meteorology (IITM). Indian Institute of Science and a few national universities are utilizing INSAT data for research in meteorology and Atmospheric Sciences. The validation of INSAT derived quantitative products is also being carried out by IMD scientists.

1.8 RECEPTION OF NOAA SATELLITE DATA

The data from NOAA series of polar orbiting satellites are received and processed by IMD at Delhi and Chennai. Both AVHRR and TOVS data are processed in real time and the cloud imagery and derived products are being utilized by the weather forecasters. The derived products are archived for distribution on demand basis to the scientists for use in research work. Based on a limited study done by IMD, the vertical temperature and moisture profiles derived from the NOAA satellite have shown positive impact on forecasts generated with numerical models. The old HRPT receiving station at New Delhi has been replaced with a new system, which is also capable of receiving data from new generation of NOAA satellites (K, L, M, N series).

1.9 PDUS for METEOSAT-5 data reception :

A PDUS receiving station had been installed in early 2000 at IMD, New Delhi for reception of high resolution imagery data from METEOSAT-5 satellite located at 63 deg E over the Indian Ocean. This system continues to be used operationally for providing cloud imagery data to the forecasters.

1.10 INDO –US data Exchange Centre

Under the bilateral programme of co-operation with USA, an INDO-US data Exchange Centre has been established at IMD, New Delhi in Nov., 99 for exchange of satellite data with USA. Processed INSAT imagery data is being transmitted every three hours to the USA. GOES imagery data is also being received from USA.

Data exchange takes place through dedicated communication links. Under another collaborative programme with EUMETSAT, an agreement had been signed for reception of METEOSAT-5 data at IMD, New Delhi after which a PDUS was established at IMD, New Delhi.

Appendix-A

INDIAN NATIONAL SATELLITE (INSAT) – PAST & PRESENT

INSAT-1 : Geostationary Satellite Series

Satellite	Launch Date	Met. Payload with Wavelength Bands	Major Applications	Active / Inactive
INSAT-1A	April10, 1982	Very High Resolution Radiometer (VHRR) Visible 0.55- 0.75µm IR 10.5 - 12.5µm	• Monitoring cyclones & monsoon • CMV Winds • OLR • Rainfall Estimation	Inactive
INSAT-1B	August 8, 1983	-do-	-do-	-do-
INSAT-1C	July 22, 1988	-do-	-do-	-do-
INSAT-1D	June12, 1990	- do-	-do-	-do-

INSAT-2 : Geostationary Satellite Series

Satellite	Launch Date	Met. Payload with Wavelength Bands	Major Applications	Active/Inactive
INSAT- 2A	July10, 1992	Very High Resolution Radiometer (VHRR) Bands : 0.55 - 0.75µm 10.5 - 12.5µm	• Monitoring cyclones & monsoon • CMV Winds • OLR • Rainfall Estimation • Mesoscale features • Flood/intense precipitation	Inactive

			advisory • Snow detection	
INSAT-2B	July23, 1993	Very High Resolution Radiometer (VHRR) Bands : 0.55 - 0.75µm 10.5 - 12.5µm	-do-	Active
INSAT-2E	April,1999	1. VHRR : As above + WV Band : 5 -7.1µm 2. CCD Payload Bands : 063 - 0.79µm 0.77 - 0.86µm 1.55 - 1.70µm	-do-	Active
METSAT	12th September, 2002	Very High Resolution Radiometer (VHRR) Bands : 0.55 - 0.75µm 10.5 - 12.5µm WV Band : 5 -7.1µm	• Monitoring cyclones & monsoon • CMV Winds • OLR • Rainfall Estimation	Active