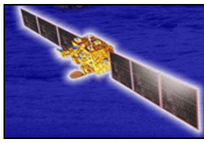

INDIA'S INSAT - 3D SATELLITE MISSION

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India is one of the few countries of the world that build, launch and operate their own meteorological satellites. In 1982, when other countries had satellites meant exclusively for meteorological remote sensing, India pioneered the concept of multi-purpose satellites that worked for telecommunications as well. The Indian National Satellite (INSAT) system was unique in this respect and designed as a joint venture of the Department of Space, Department of Telecommunications, India Meteorological Department, All India Radio and Doordarshan to provide telecommunication, television broadcasting, meteorology and disaster warning services.

Since 1982, the Indian Space Research Organisation has launched a series of geostationary satellites that have provided a continuous meteorological coverage of the Indian subcontinent, the surrounding land and Indian Ocean regions. Four satellites in the INSAT-1 series, three in the INSAT-2 series, the dedicated Kalpana-1 satellite, and the current INSAT-3A satellite, have carried a total of nine Very High Resolution Radiometer (VHRR) instruments so far, besides the Charge Coupled Device (CCD) cameras on the more recent satellites. The next satellite, INSAT-3D, to be launched later in 2008 will have an advanced 6-channel imager and a 19-channel sounder. These will offer new capabilities for obtaining high resolution images in new channels and deriving vertical profiles of temperature and moisture.

The Indian satellites INSAT-1A to -1D, and INSAT-2A and -2B carried a 2-channel Very High Resolution Radiometer (VHRR). Their resolutions at the sub-satellite point were 2.75 and 11 km respectively for INSAT-1A to -1D, and 2 and 8 km respectively for INSAT-2A and -2B. The INSAT-2E satellite, for the first time carried a 3-channel VHRR with a water vapour channel (WV) 5.7-7.1 µ added to the VIS and TIR channels. The ground resolution of the WV channel was 8 km. Further information is given in Table 1.

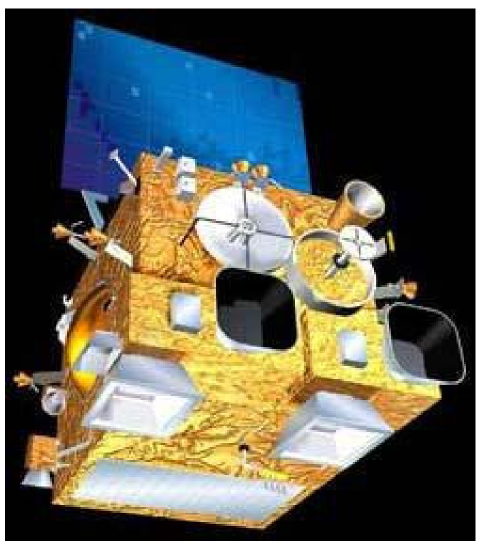
Satellite-derived Atmospheric Soundings

Knowledge of the temperature and humidity distribution in the vertical is essential for obtaining a complete three-dimensional representation of the atmosphere. The conventional method of measuring vertical profiles of temperature, water vapour or any other atmospheric parameter is to release a balloon carrying a suitable instrument package that would sense the parameter and transmit the data to a ground station. In a radiosonde, which is the most widely used instrument for this purpose, an electronic package with a transmitter is attached to the balloon and the sensors measure pressure, temperature and humidity at various levels as the balloon rises. The signals received at a ground station are decoded to obtain the vertical profiles of temperature, humidity and other parameters. Most upper air stations take two radiosonde ascents per day at the synoptic hours of 00 and 12 UTC.

Radiosonde data have various types of inherent errors and uncertainties. In addition, national meteorological services use radiosonde instruments of different makes and designs, and employ different ground computation procedures. This requires them to undertake rigorous inter-comparisons periodically so as to maintain compatibility amongst the instruments and uniformity in the global synoptic analyses. Radiosondes are expandable instruments which are becoming increasingly costlier and many countries are finding it difficult to maintain their radiosonde networks.

Polar orbiting satellites and some geostationary satellites, on the other hand, can provide a repetitive, globally consistent sounding capability on land and oceanic areas alike. The soundings are available on a finer grid but they differ from the radiosonde in the scale on which they sample the atmosphere in both horizontal and vertical dimensions. While the radiosonde measures the local environment, satellite profiles are averages of horizontal and relatively deeper layers of the atmosphere. Absolute accuracy of satellite soundings is difficult to establish. With every satellite pass, a fresh retrieval is possible, hence more frequent profiles can be obtained compared to radiosondes.

There are three types of retrieval algorithms - statistical, physical and hybrid - none of which can be said to have a clear superiority over the others. Although the physical principle of atmospheric sounding is the same for a polar orbiting or geostationary satellite, sounding instruments on geostationary satellites demand far greater sensitivity and precision because of the small amount of radiances that they have to measure at geostationary height in the same spectral bands. Out of the many geostationary meteorological satellites located around the globe, only GOES has so far been carrying a sounder. The first GOES sounder was the VISSR Atmospheric Sounder (VAS) which was rather a more advanced version of the Visible Infrared Spin Scan Radiometer (VISSR) carried by earlier GOES satellites.



INSAT-3D Sounder

The INSAT-3D satellite which is scheduled for launch later this year, will carry for the first time a sounder payload. This will make it much easier to get the data in real time and process it faster, enabling its quick assimilation by numerical models. Since INSAT-3D will be a geostationary satellite, many soundings can be made at small time intervals over the region covered by the INSAT full disc than what are currently available from other means.

The INSAT-3D sounder instrument will be capable of making soundings at 10 km ground resolution every 3 hours for a full frame scan. Derivation of vertical profiles of temperature and humidity over 30 x 30 km areas will be possible. The INSAT-3D 19-Channel Sounder characteristics are given in Table 2. The data from the INSAT-3D sounder will be processed operationally to retrieve basically the vertical profiles of temperature and humidity. These vertical profiles can then be used to derive various atmospheric stability indices and other parameters such as atmospheric water vapour content. The total column ozone amount can also be retrieved.

A major advantage of the INSAT-3D soundings is that they can be obtained at an interval of every 3 hours, compared to the twice-a-day radiosonde observations. The other significant gain would be the coverage over the Bay of Bengal, Arabian Sea and the Indian Ocean, which are presently devoid of sounding data, except from a few island stations. The vertical temperature and humidity profiles obtained from INSAT-3D over the Indian Ocean in particular can serve as input to Numerical Weather Prediction models for initialization as well as for validation purposes.

Some of the likely areas of application of INSAT-3D sounder data are obviously in investigations related to aspects of the southwest monsoon such as its onset over Kerala, the development of the trough along the west coast of India, and the formation of low-level inversions over the Arabian Sea during the monsoon.

INSAT-3D Imager

The INSAT satellites, because of their geostationary position, keep a round-the-clock vigil on all scales of weather phenomena, ranging across mesoscale systems, thunderstorms, monsoon depressions, western disturbances and tropical cyclones. The genesis, development and decay of these phenomena can be watched, and the movement of migratory systems can be tracked. INSAT cloud imagery also helps in identifying primary synoptic systems such as low pressure areas, troughs and ridges, tropical and extra-tropical jet streams, easterly waves or the Inter-Tropical Convergence Zone. However, the spatial resolution of the satellite imager and the period between two successive scans have an important bearing on what meteorological phenomena can be observed or are likely to be missed by the imager. From this point of view, the INSAT-3D imager is going to significantly enhance the applications capability.

The INSAT-3D imager will have 6 channels as against the 3 channels in the current radiometers. The visible channel will have a resolution of 1 km compared to the presently available 2 km resolution. This will enable mesoscale phenomena and severe local storms to be monitored much better than now. INSAT-3D will have two new channels, (shortwave IR) 1.55-1.70 m and (midwave IR) 3.80-4.00 m with a resolution of 1 and 4 km respectively. These will enable better land-cloud discrimination and detection of surface features like snow. One more significant improvement is the split-channel thermal IR channel with two separate windows in 10.2-11.2 and 11.5-12.5 m regions with a 4 km resolution. This new element will enable the extraction of sea surface temperature over the Indian region with a far greater accuracy since the dual-window algorithm can be applied to eliminate the atmospheric attenuation effects. The 1 km resolution of the visible channel and 4 km resolution of the thermal IR channels will indirectly improve the accuracy of the derived products like outgoing longwave radiation and cloud motion vectors.

Conclusion

The proposed launch of the INSAT-3D satellite is going to be yet another demonstration of India 's superior capability in the area of meteorological remote sensing. Two more missions, the Indian 'Oceansat-2' and the India-France joint venture 'Megha-Tropiques', are expected to follow in quick succession. When all these satellites are in orbit, they will provide a space view of the total land-ocean-atmosphere system as never before. Together they will not only cater to the growing needs of operational meteorology but also throw new light on the physical processes of the atmosphere and ocean that govern our monsoons.

About the Author

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