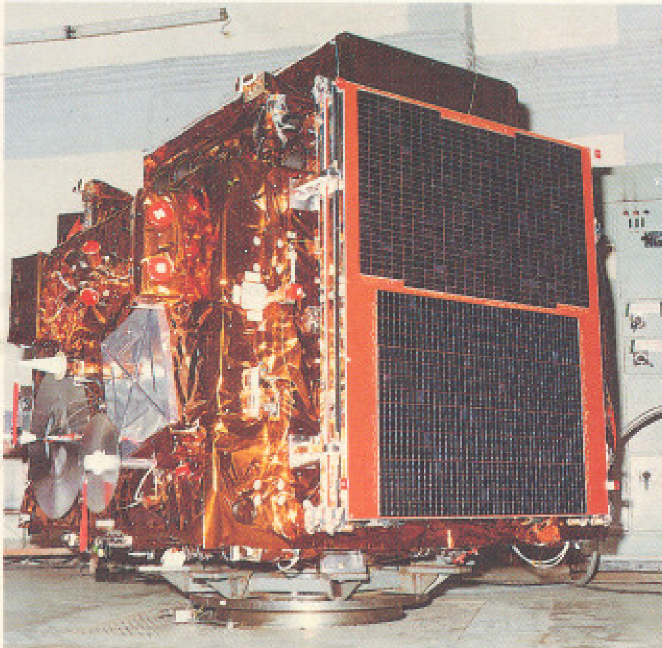
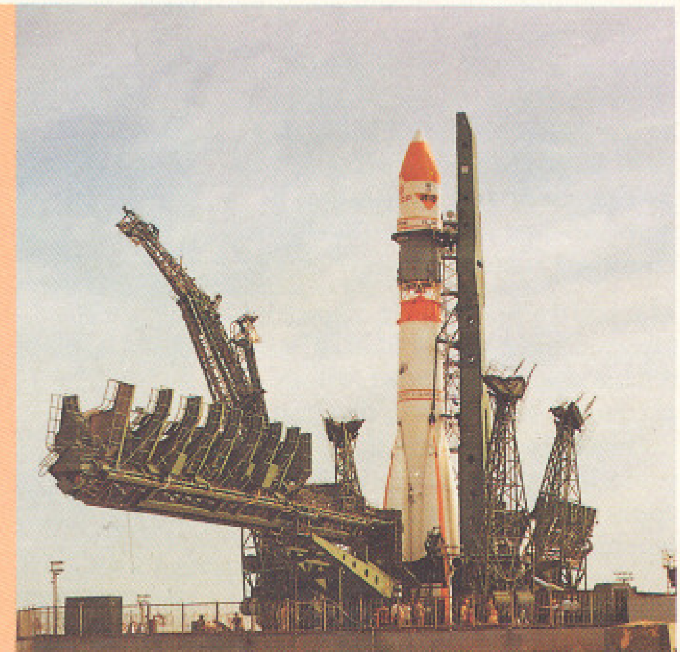
3/1991

SPACE india





INDIAN SPACE RESEARCH ORGANISATION

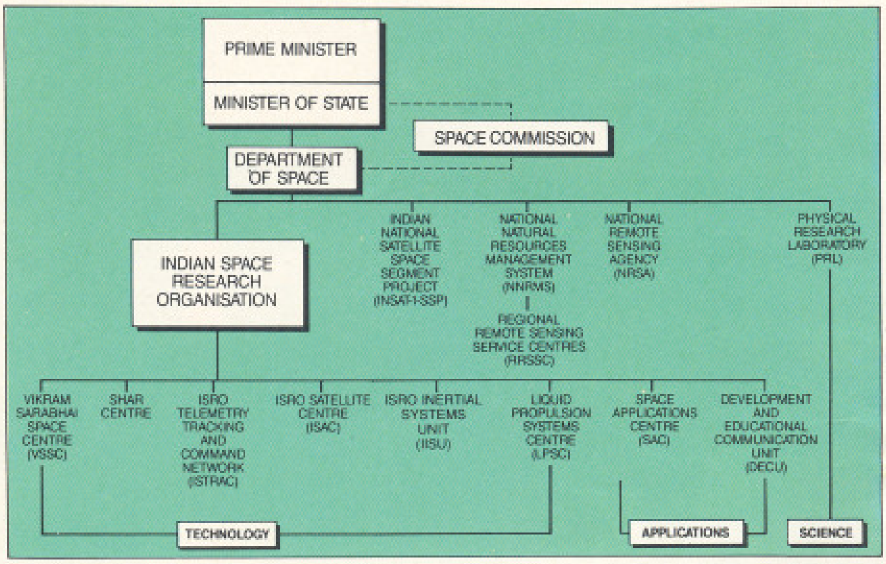
The Indian Space Programme

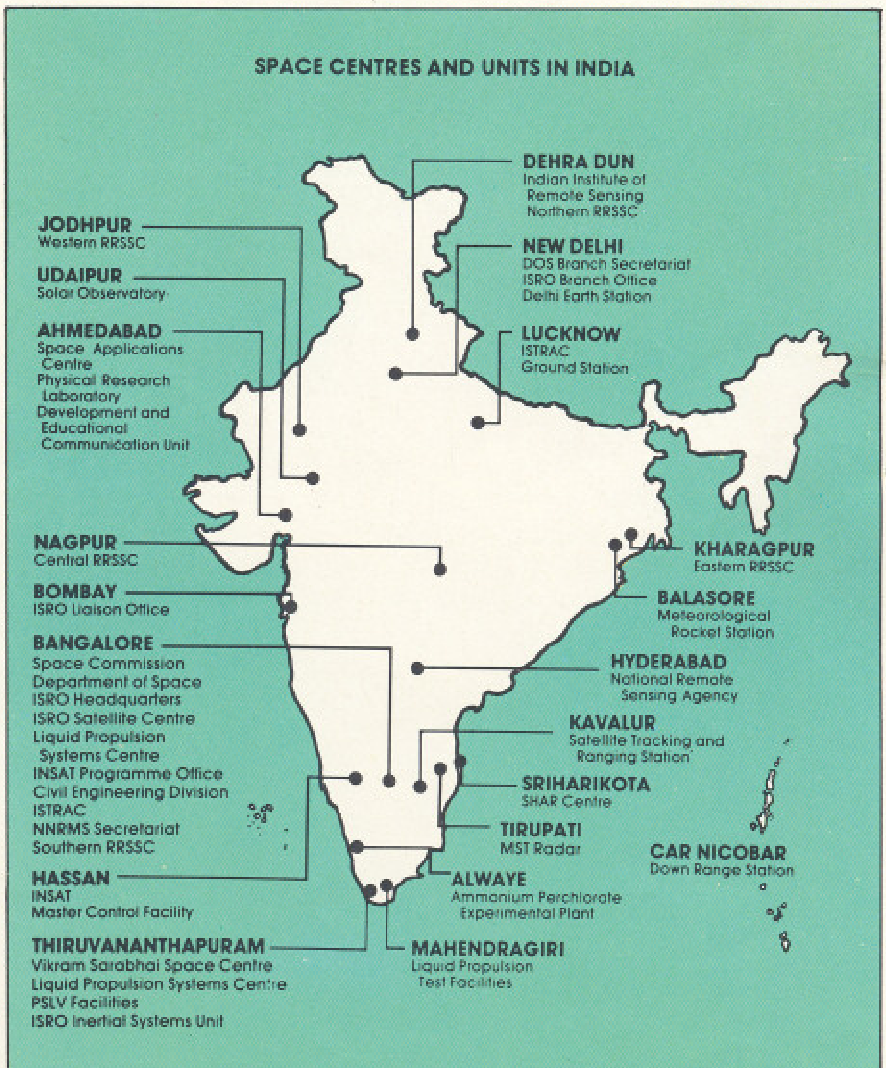
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science and technology for identified national objectives.

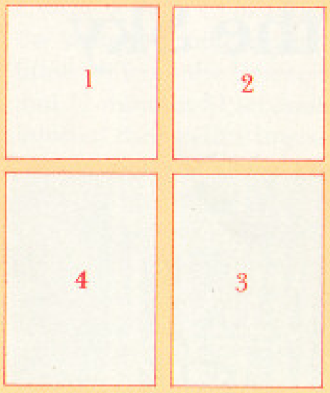
The Indian Space Programme is directed towards the goal of self-reliant use of space technology for national development, its main thrusts being: (a) satellite communications for various applications, (b) satellite remote sensing for resources survey and management, environmental monitoring and meteorological services and (c) development and operationalisation of indigenous satellites and launch vehicles for providing these space services.

The Indian Space Research Organisation (ISRO) is the research and development wing of DOS and is responsible for the execution of the national space programme. ISRO also provides support to universities and other academic institutions in the country for research and development projects relevant to the country's space programme.

Both the DOS and ISRO Headquarters are located at Bangalore. The development activities are carried out at the Centres and Units spread over the country. □







FRONT COVER

1. *IRS-1B Satellite*
2. *VOSTOK Rocket*
3. *ISTRAC Station*
4. *First imagery from IRS-1B*

July - Sept., 1991

SPACE india is published quarterly by the Indian Space Research Organisation for limited circulation. Articles appearing in *SPACE india* may be reproduced accompanied by the credit line "Reprinted from *SPACE india*" along with the date of issue.

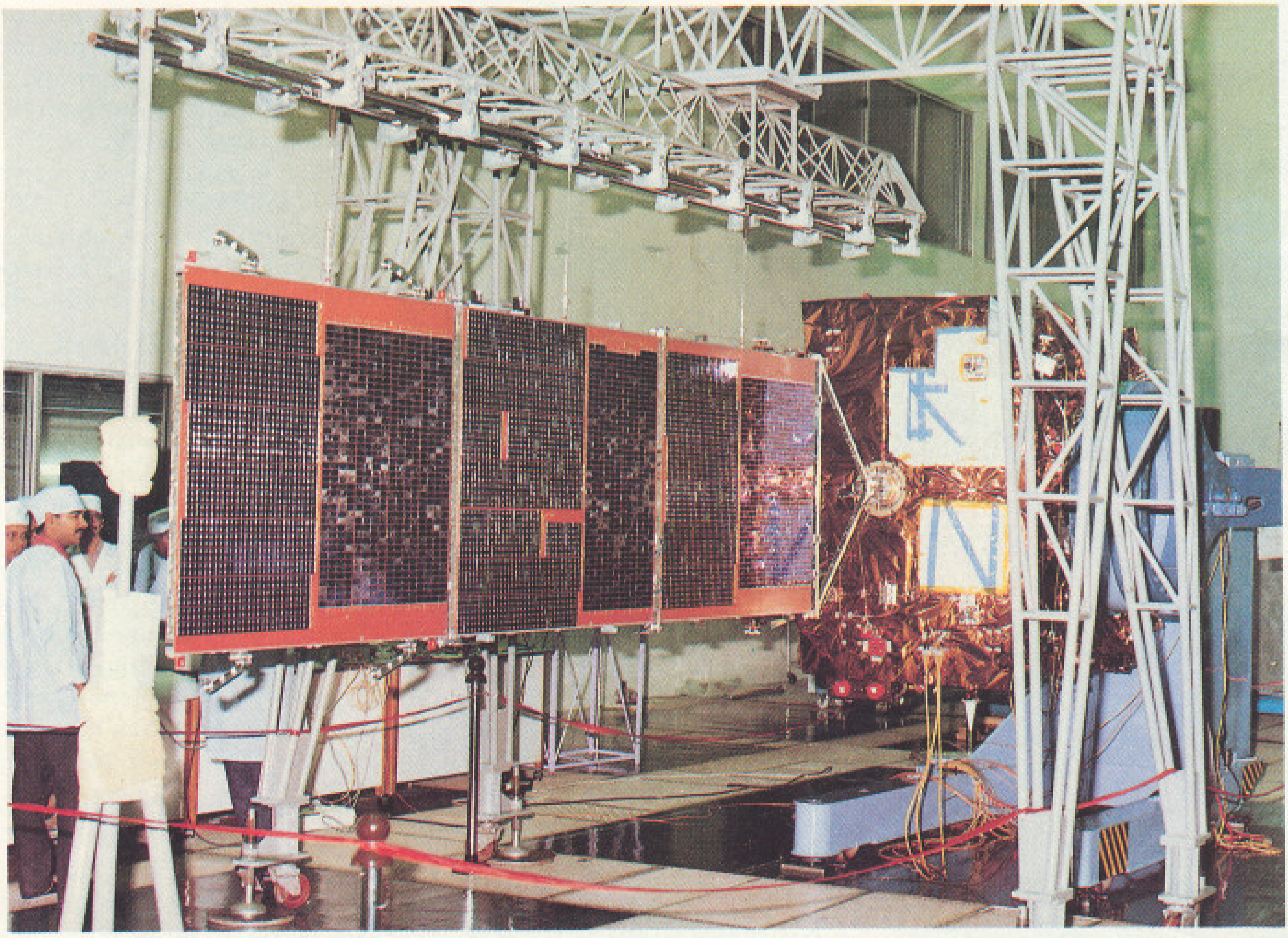
Editorial/Circulation Office:

Publications & Public Relations Unit, ISRO Headquarters, Antariksh Bhavan, New BEL Road, Bangalore 560 094. India.

Printed at Thomson Press, Faridabad, India

Contents

IRS-1B, The Second Eye in the Sky



IRS-1B, Solar panel deployment test

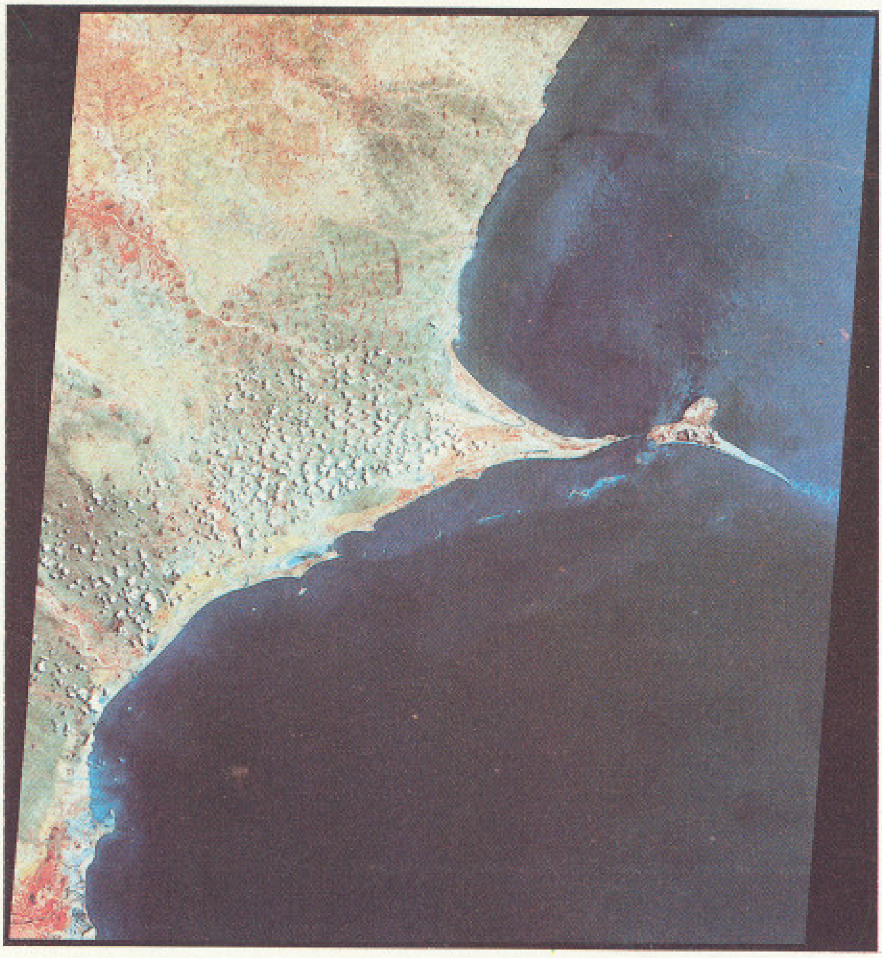
The successful launch of the second state-of-the-art operational Indian Remote Sensing satellite, IRS-1B, on August 29, 1991 on board the Vostok launcher from Baikonur Cosmodrome in the USSR and subsequent in-orbit operations on the satellite including deployment of solar panels, sun acquisition and earth acquisition, switching on the first set of camera system, LISS-I, on August 30, 1991 and the second set of camera system, LISS-II, on September 6, 1991; all of which were conducted with clockwork precision resulting in the satellite being declared fully operational in its final intended orbit on September 16, 1991, are significant achievements. While the launch of the first Indian Remote Sensing satellite, IRS-1A, on March 17, 1988 marked the beginning of indigenous building of operational satellites and ushered a new era in the management of natural resources in the country, the success of IRS-1B is an unequivocal demonstration of the Indian capability in the satellite technology and a reiteration of the commitment of the Indian space programme to provide satellite based remote sensing data services to the nation on an assured and continuous basis.

The 990 kg, IRS-1B satellite was airlifted from Bangalore on July 18,1991 after it had successfully undergone environmental and electrical tests. The activities at the Baikonur Cosmodrome, which began the very next day, included a series of mechanical and electrical ground checks, alignment of attitude sensors and the three imaging camera systems, deployment tests on the solar panels under simulated zero 'g' conditions, battery checks and fuel loading and pressurisation operations. The satellite was mated with the third stage of Vostok on August 25,1991. The Launch Authorisation Board, chaired by Prof U.R.Rao, Chairman, Space Commission, met on August 27, 1991 and after a detailed review of the readiness of all the systems involved, namely, the rocket, the satellite, the Spacecraft Control Centre at Bangalore and the network of ground stations, cleared the launch for August 29, 1991 as scheduled.

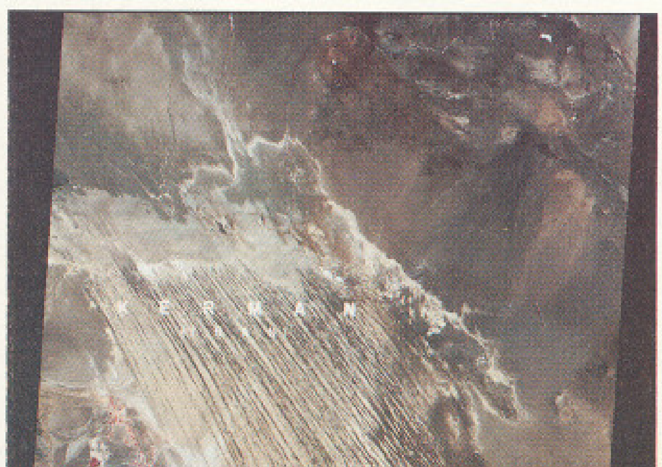
Exactly at 12 h, 18 m and 44 s IST, the Vostok rocket carrying IRS-1B lifted off from the Cosmodrome and 11 minutes 31 seconds later injected the satellite into the orbit. The Spacecraft Control Centre (SCC) of the ISRO Telemetry, Tracking and Command Network (ISTRAC) at Bangalore was in full command of the satellite when the solar panels of IRS-1B were deployed 1 m 45 s after injection into the orbit. The sun acquisition manoeuvre was completed in the next 4 m and the satellite was prepared for earth acquisition.

At 1045 h IST on August 30, 1991, after earth acquisition and three-axis stabilisation of the satellite, the first set of camera system, LISS-I, was switched on and IRS-1B started beaming excellent pictures of regions around Allahabad, Tirupati, Sriharikota and Rameswaram.

The second set of cameras, LISS-IIA and LISS-IIB, were successfuly operated on September 6, 1991 when the satellite covered areas over Gulf of Oman and Muscat city in its 113th orbit around the earth. The operation of the second set of cameras was preceded by checking out of the LISS-II X-band data transmission



Rameswaram and surrounding areas as seen by IRS-1B on August 31, 1991



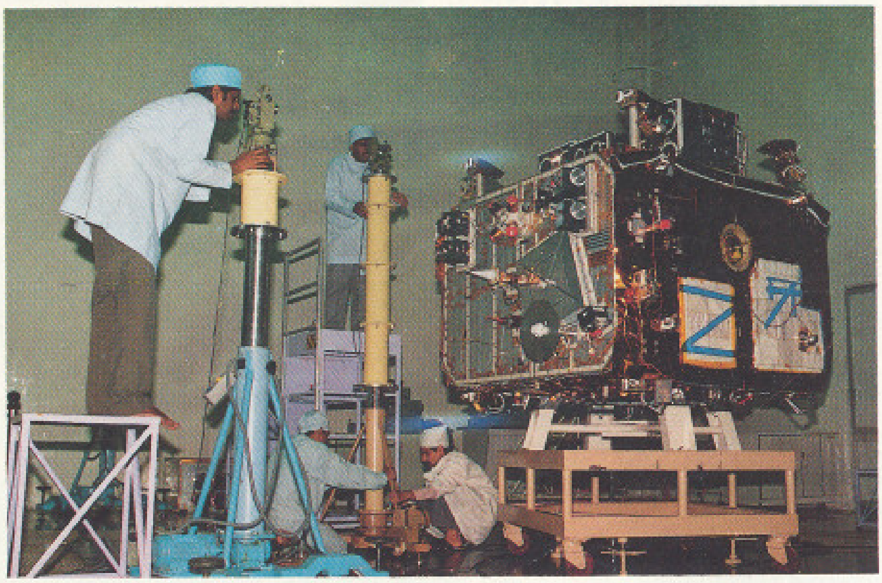
Imageries obtained on August 30, 1991 over Iran system in the previous orbit. Since then, the data reception station of the National Remote Sensing Agency (NRSA) at Shadnagar near Hyderabad is receiving LISS-I and LISS-II imageries from IRS-1B regularly. Processing of these imageries is being carried out at the NRSA facility at Balanagar, Hyderabad.

With all the post-launch operations having proceeded without any hitch, IRS-1B was declared operational on September 16, 1991.

Even though the first satellite in the IRS series, IRS-1A, has already completed its design life of three years in March this year, it is still performing quite satisfactorily. It has been the mainstay of the National Natural Resources Management System and has so far covered India more than 55 times. About 4,00,000 high quality imageries provided by IRS-1A have been put to effective use in a variety of fields.

The IRS-1A and 1B imageries are comparable in quality and utility to those obtained from the French SPOT and the American LANDSAT satellites. India is among the select group of countries to have operationally used remote sensing technology for the management of its natural resources. During the period when both IRS-1A and IRS-1B are available, the country will have more frequent satellite coverage than was hither to been possible; this enhances scope for monitoring dynamic features associated with agriculture, flood, water resources, etc.

Coming in quick succession, the success of IRS-1A and IRS-1B satellites, clearly demonstrate ISRO's prowess in spacecraft technology, besides putting the Indian Remote Sensing programme on a firm footing. Further, the vast and varied experience gained through the two campaigns has enabled ISRO to realise the second generation satellites IRS-1C and IRS-1D, with greater confidence. ◻



Alignment checks on IRS-1B

Salient Features

ORBIT

Altitude	*904 km (circular polar sunsynchronous)*
Repetitivity	*22 Days*
Local Time of equatorial crossing	*10.30 am (descending node)*

PLATFORM

Control	*3-axis body stabilised using reaction wheels, magnetic torquer and reaction control system*
Sensors	*Sun, Earth and Star sensor and DTG*
Power	*650-700 Watt*
TTC frequency	*S-Band*
Payload data transmission	*S & X Bands*

PAYLOAD

Linear Imaging Self Scanners (LISS)		
	LISS-I	*LISS-IIA & IIB*
Spatial Resolution	*72.5 m*	*36.25 m*
Swath	*148 km*	*74 km each (146 km composite)*

Spectral Bands	***Applications***
0.45-0.52 micrometre	*coastal water mapping and soil/vegetation differentiation*
0.52-0.59 micrometre	*green reflectance of heavy vegetation*
0.62-0.68 micrometre	*chlorophyl absorption of plants*
0.77-0.86 micrometre	*biomass surveys and water bodies*
Radiometric resolution	*128 levels*

Statement by the Prime Minister in the Parliament

Courtesy: "Parliamentary Museum & Archives", Lok Sabha Secretariat

Nine hundred kilometres above the surface of the earth, India's second indigenous Remote Sensing Satellite is circling the earth. IRS-1B was launched successfully at 19 minutes past noon today, Indian time, from Baikonur Cosmodrome in the Soviet Union.

All systems and subsystems of IRS-1B satellite have been designed and fabricated indigenously. It weighs less than a thousand kilograms and carries three sets of state-of-the-art imaging cameras.

Our nation's most experienced hands are controlling the satellite at the ISRO Telemetry, Tracking and Command Network (ISTRAC) Spacecraft Control Centre at Peenya, Bangalore. This is connected to other ISRO tracking ground stations at Lucknow and Mauritius. During the initial phases of the mission, ground stations of foreign space agencies located in the USSR, Kenya, USA and Germany are assisting in monitoring the performance of the satellite.

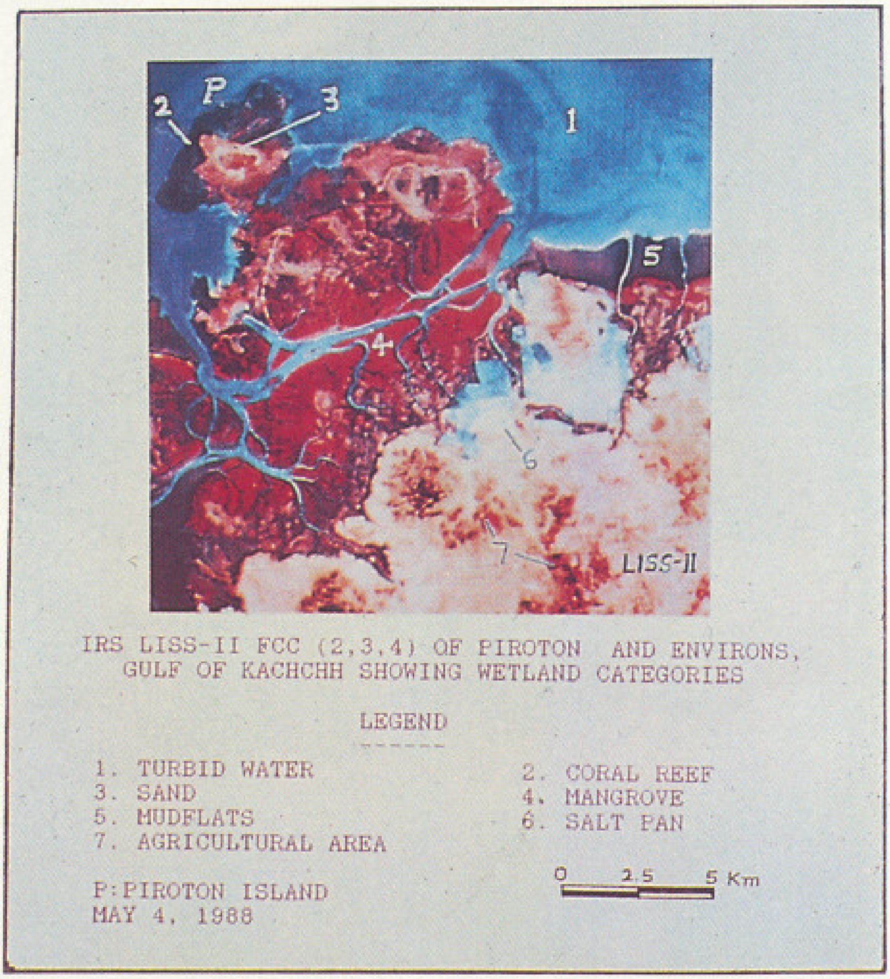
Remote sensing is an important area of space applications all over the world today. For a developing country with diverse geological features, it is critically relevant in providing vital inputs for the management of our vast land and ocean resources.

The successful launch of IRS-1B marks our commitment to use space technology to provide operational services on a continued and assured basis in the vital areas of natural resources management. It also represents a continuation of our commitment to use science for peaceful, constructive and developmental ends which can be translated into areas of tangible benefit for our people. We are determined, with the support of our Parliament and people, not only to preserve the position of Indian science at the frontiers of professional excellence and international recognition, but to make it a vital instrument in fulfilling national needs.

Shri P.V. Narasimha Rao, Prime Minister of India

I am sure the House would wish to join me in extending our felicitations to the Scientists, Engineers and supporting staff of the Indian Space Research Organisation whose dedicated efforts have brought this great success to the nation. This reaffirms our pride in being Indian.

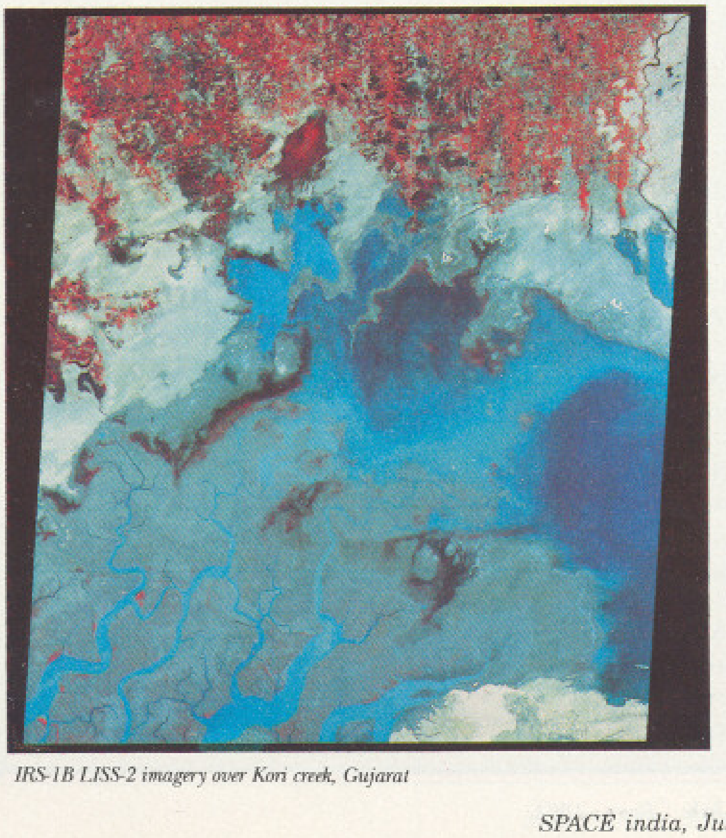
Satellite Data for Oceanography



Exploitation of ocean resources has assumed great importance today due to rapid growth in population and urbanisation resulting in increased demands on resources. Effective management of ocean resources needs a thorough understanding of the associated physical, chemical and biological processes as well as the interaction of oceans with land. Paucity of reliable data has been one of the main stumbling blocks in our understanding of the oceans. Further, the conventional methods of data collection are expensive and time consuming. With the advent of remote sensing using satellite and aircraft, the data coverage and accessibility to data have increased tremendously. The satellite data in particular have the advantage of wide coverage.

Satellite remote sensing data have already proved their utility in oceanographic studies. For example, the ocean colour as detected by a sensor has a direct relationship with the suspended material in the water, thermal characteristics, presence of biological matter, etc. The ocean circulations and currents caused primarily by winds can be studied using satellite microwave sensors like altimeter.

The thermal structure of streams and ocean currents can be mapped using infrared radiometry. Another important parameter that has been measured with reasonable accuracy is the Sea Surface Temperature (SST). Several new techniques are now available which help overcome the influence of atmospheric constituents on the SST retrieval. Microwave sensors can be effectively used for bathymetry, mapping of sea-ice features, etc. Information on wetlands, geomorphology,



IRS-1B LISS-2 imagery over Kori creek, Gujarat erosion/accretion, sediment transport, etc., data on which can be obtained from satellite based remote sensing, is important for scientific management of the coastal zone.

Satellites such as IRS-1A and IRS-1B, LANDSAT and SPOT, with their synoptic and repetitive coverage, provide information on many aspects related to the coastal zone. Dynamic features such as estuarine conditions, mud flats, river mouth sedimentation, pollution levels, etc., can be best monitored through the repetitive coverage provided by satellites.

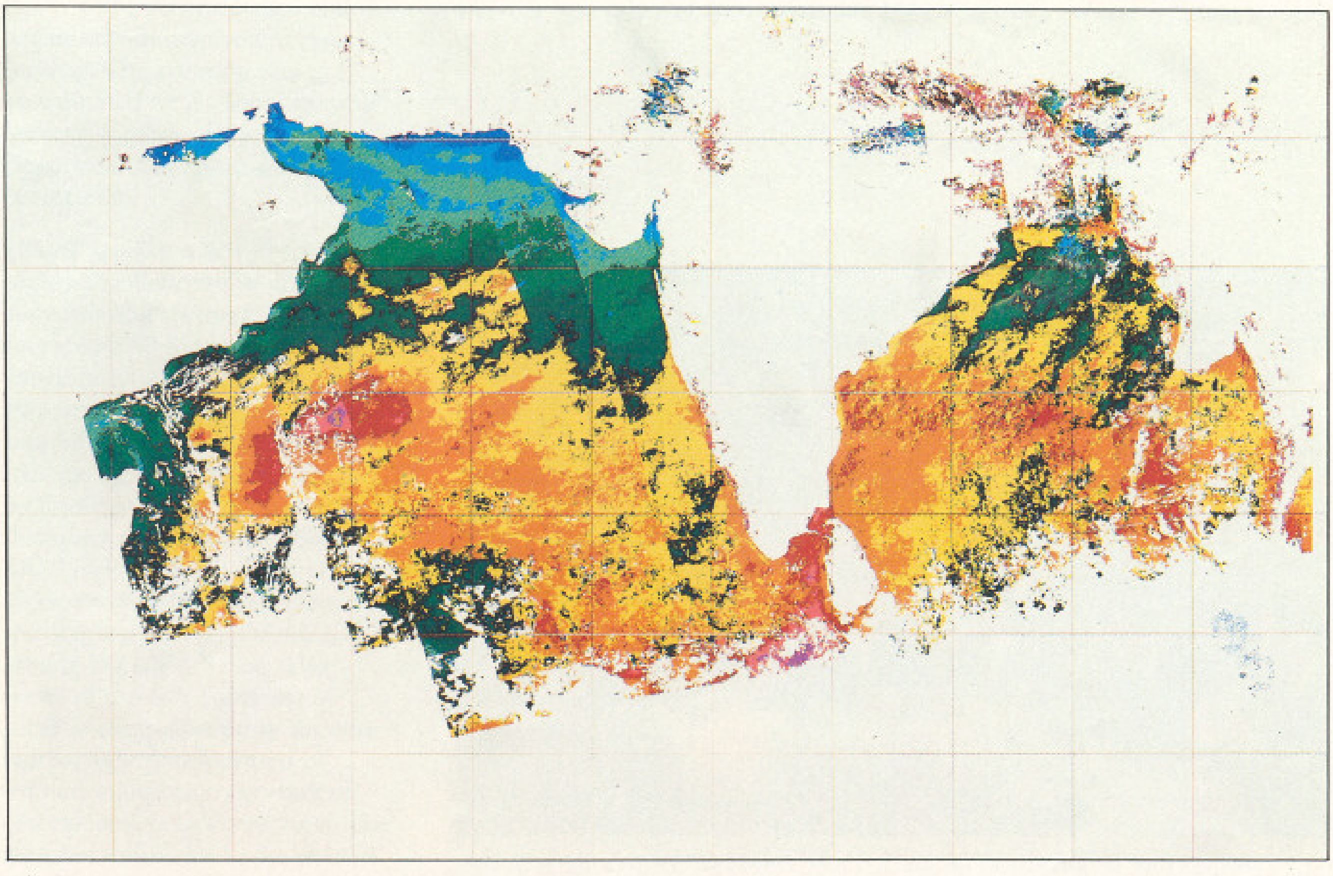
Considering the potential of remote sensing techniques, India has initiated a programme for utilisation of satellite data for oceanographic applications. The indigenously built Indian Remote Sensing satellites, IRS-1A and IRS-1B, form an important component of this programme.

The interaction between different elements like lithology, structure, climate, etc., plays a vital role in the geomorphic evolution of the coast. The satellite can provide information on many geomorphic features originating from structural processes, denudation, fluvial processes and marine processes. Such information is useful in studying coastal zone features such as mangroves, wetland, saltpans, creeks, estuaries, lagoons, beaches, etc. The remote sensing data can be used for updating information on coastal zone landuse and characteristics.

Information on coastal vegetation is of economic importance. Remote sensing is useful in inventorying coastal vegetation. *Insitu* measurements using radiometry, in conjunction with satellite data to determine reflectance signatures, help distinguishing vegetation canopies.

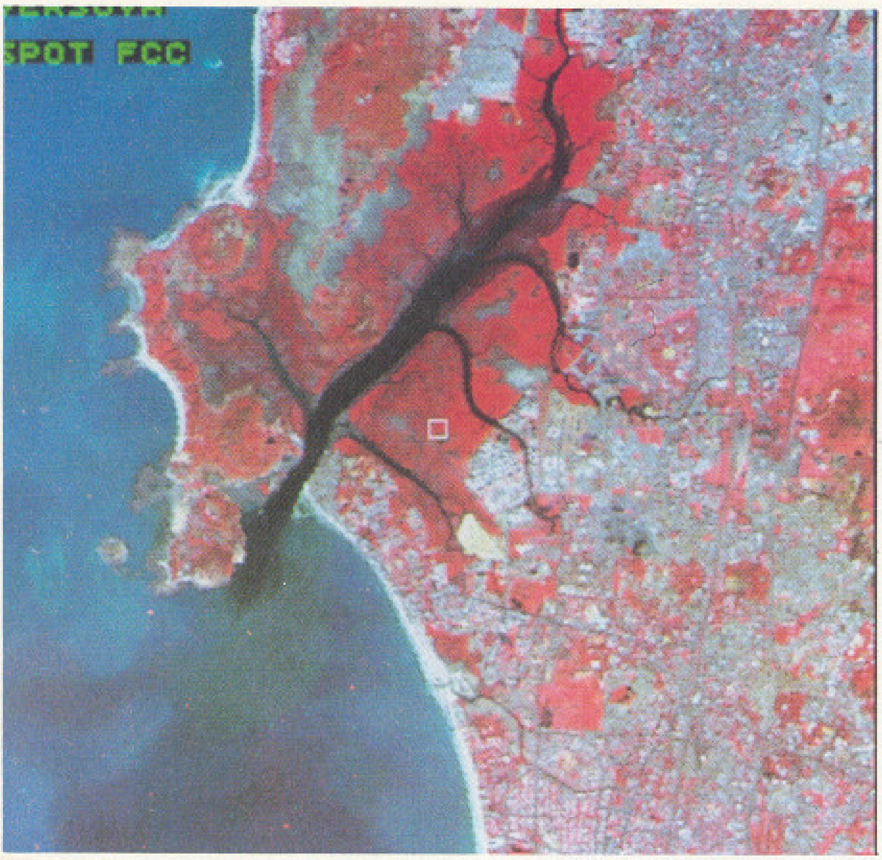
Transport of sediments in littoral zone (a zone extending from the shoreline to the tidal zone – up to a depth of 100 fathoms) by waves and currents is of importance in coastal engineering applications and estimation of erosion and accretion rates along the shore. Under ideal conditions, the near-shore profiles can be utilised in determining longshore transport rates. Satellite data, when used in conjunction with *insitu* optical data, navigational charts and nearshore profiles, have been of great value. Though the currently available satellite sensors are not optimised for ocean studies, they have been useful in studying coastal processes such as erosion, accretion, etc.

The main sources of suspended matter in sea water are river run-off, biological productions and coastal erosion. The amount of suspended sediment load is important in deciding the dynamics of the ocean bottom flow. Several studies have indicated that a good correlation exists between the visible and near-IR reflectance values of water bodies and sediment load. The 0.6 to 0.7 micrometre band is found



Weekly composite map of sea surface temperature over Indian ocean to give sharpest definition of coastal waters of varying turbidity. Extensive atmospheric corrections have, however, to be applied to the data to get more accurate results.

Another important aspect of the physiography of the coast is the study of river mouths and sediment transport near the coast. Satellite data have been found to be sensitive to turbidity of coastal waters and hence useful in studying estuarine siltation and formation of mudflats. The interaction of the waves and the beach causes changes in the beach profile from time to time affecting near-shore bathymetry. With the knowledge of the sediment load in the surface layers, it is possible to correlate satellite radiance values with ocean depth. Another approach is to use data from Synthetic Aperture Radar which is sensitive to land-ocean features. ¤



Imagery over Bombay - Varsova creek region

ESCAP – Regional Remote Sensing Programme Meeting held in Hyderabad

The meeting of the Directors of National Remote Sensing Centres/Programmes in the ESCAP (Economic and Social Commission for Asia Pacific) region and the 8th Session of Inter-governmental Consultative Committee of the Regional Remote Sensing Programme (RRSP) under UNDP, were held at the Bhaskara Palace, Ashok Hotel, Hyderabad during September 9-14, 1991. The meeting was attended by representatives from 20 countries in the region including India. The meeting was also attended by representatives of UNDP, observers from USA, Germany, USSR, Sweden and Japan and other international organisations involved in remote sensing. The meeting was coordinated by National Remote Sensing Agency of the Department of Space and RRSP Secretariat.

ESCAP has been actively pursuing regional collaboration and coordination through UNDP funded RRSP for providing continuous assistance to member countries in building up national capabilities for developing and harnessing remote sensing technology as part of their natural resources development effort. RRSP of ESCAP has the main objective of promoting remote sensing technology utilisation among the ESCAP countries. Some of the achievements of RRSP since its inception six years ago include development of trained manpower, conduct of several joint projects between the member countries in the field of flood monitoring, mineral

Prof. U.R. Rao, Chairman, Space Commission, ISRO, inaugurating the meet by lighting the lamp.

From left to right, Prof. B.L. Deekshatulu, Prof. U.R. Rao, Mr. Guangchang Shi, Mr. Changchui, Mr. M.U. Chaudhury and Mr. H. Diederix exploration, geological investigation, desertification study, urban sprawl mapping and establishment of remote sensing training centres.

India has been playing an important role in the activities of RRSP; recently, it has extended technical assistance to the ESCAP/UNDP project on assessment of economics of remote sensing applications to national resources and environment development, a project funded by the Asian Development Bank. India has also been sponsoring long term fellowships for the developing countries in the ESCAP region through the Sharing of Experience in Space (SHARES) programme.

Prof. U.R. Rao, Chairman, Space Commission, Government of India, who is also the Chairman of the Inter-governmental Consultative Committee (ICC) of RRSP, was the Chief Guest during the opening session of the meeting on September 9, 1991. In his introduction to the theme topic of the meeting 'Remote Sensing for Sustainable Development of Natural Resources and Environment Management', Prof Rao emphasised the need for optimal management of natural resources and environment with a long term perspective. He stressed the importance of satellite remote sensing for working out environmentally sustainable development strategies at microlevel. Prof Rao also urged upon Asia Pacific countries to come together to form Asia Pacific Natural Resources Management System (APNRMS) under which the available expertise of all the countries in the region could be pooled to enable them to exploit fully the benefits from space remote sensing.

The week-long meeting of ESCAP-RRSP at Hyderabad was helpful in promoting exchange of visits, training programmes, seminars and symposia and collaborative projects, under the RRSP. During their stay at Hyderabad, the participants visited the facilities of National Remote Sensing Agency (NRSA) including the Data Reception and Processing Facilities of the Indian Remote Sensing satellites, IRS-1A and IRS-1B. ◻

NRSA starts receiving ERS-1 Data

The National Remote Sensing Agency (NRSA), Hyderabad, has started receiving the Synthetic Aperture Radar (SAR) data from the European Remote Sensing satellite, ERS-1, of the European Space Agency (ESA) which was launched on July 17, 1991. An agreement for receiving the data from ERS-1 was signed in June 1991 between Prof U R Rao, Chairman, Space Commission and Secretary, Department of Space and Mr. Jean Marie Luton, Director-General, ESA.

SAR, the main payload on board ERS-1, operates in the C-band microwave region and can produce imageries with a ground resolution of 30 m with a swath of 100 km. Images obtained from SAR provide information on dielectric constant, surface roughness, surface geometry, etc., of the target area and hence present a view different from those obtained using optical cameras which represent surface colour and temperature. The major advantage of SAR is its ability to obtain imagery even under cloud cover and irrespective of illumination conditions.

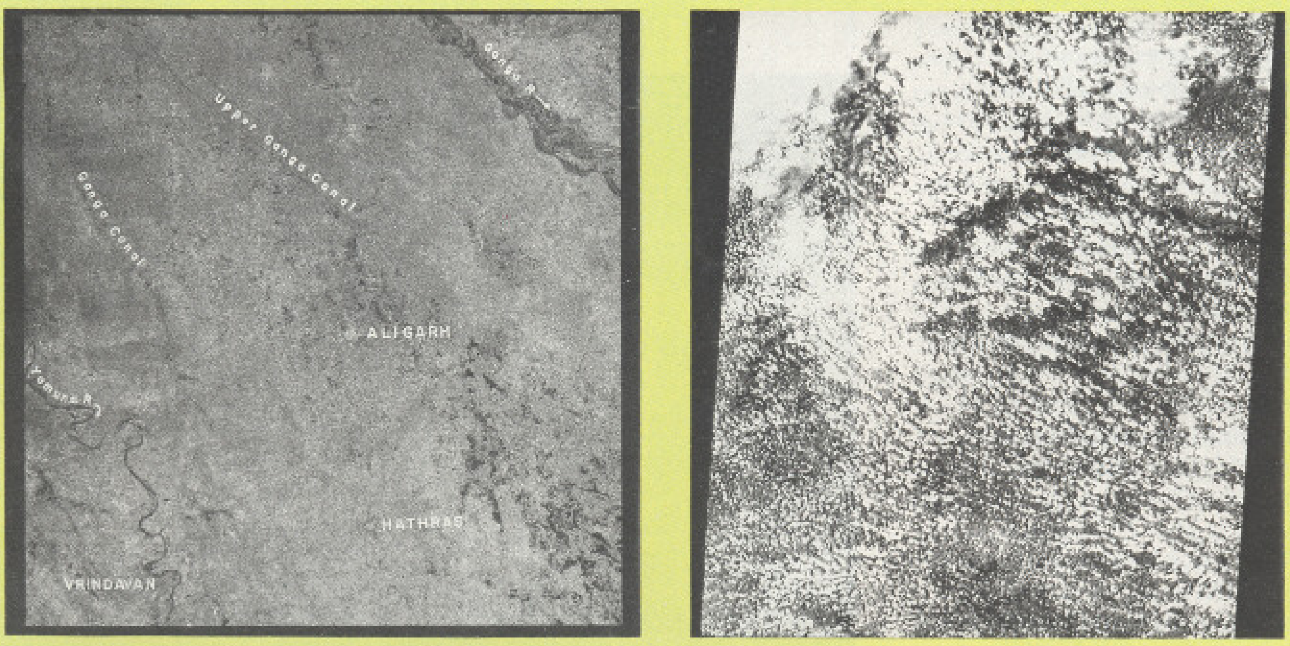
Apart from SAR, ERS-1 also carries
a) Wind Scatterometer for providing information on ocean surface, wind speed and direction,
b) Wave Scatterometer for providing information on the ocean wave spectra,
c) Radar Altimeter for providing information on ocean surface height, significant wave height and wind speed,
d) Along-track Scanning Radiometer and Microwave Sounder providing data on sea surface temperature and atmospheric water vapour content,
e) Precise Range and Range Rate experiment and
f) a Laser Retroreflector.

The Landsat receiving station at NRSA has been augmented to receive and process ERS-1 data. The software for image processing of microwave data has been developed by ISRO.

The data from IRS satellites, supplemented with SAR data from ERS-1 which can be obtained under cloudy conditions as well as during night, will become a powerful tool for the extension of space remote sensing application to several new fields.

The Department of Space has already an on-going programme of utilising air-borne Side Looking Radar and Synthetic Aperture Radar. The agreement with ESA under which SAR data from ERS-1 are being received by NRSA will enable us to use space remote sensing data along with air-borne data for a wide range of applications hitherto felt to be impractical.

(C) ESA (1991)



One of the first SAR images over India obtained from ERS-1 during the test transmission on August 20, 1991 (left) when the area was heavily cloud covered as shown in the IRS imagery obtained around the same time (right)

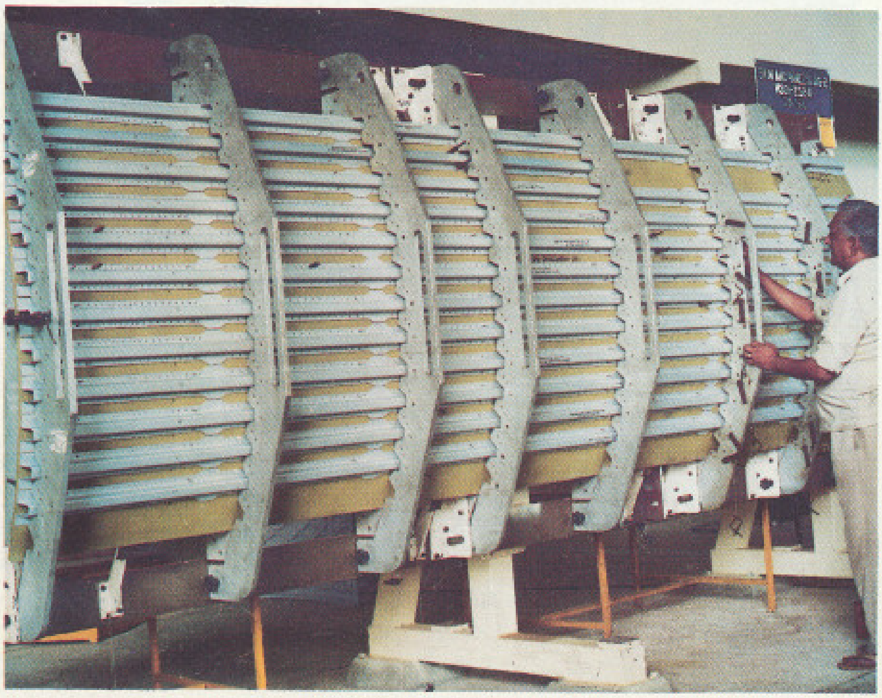
ISRO - HAL Cooperation in Space

The cooperation between ISRO and the public sector undertaking, Hindustan Aeronautics Limited (HAL) entered a new era with the setting up a new production facility – Aero Space Division (ASD) – at HAL, Bangalore. The facility, which was inaugurated by the Prime Minister on April 6, 1991, has some of the most modern equipment for precision machining, welding, inspection, and adequate capacity for high-tech surface treatment and heat treatment of large size space hardware.

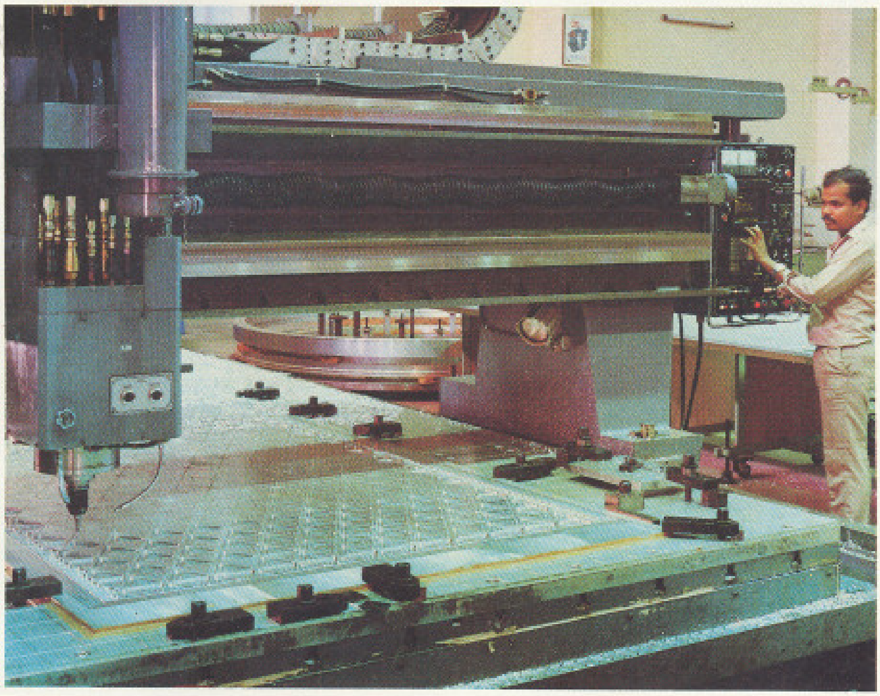
HAL has been helping ISRO in all its satellite and launch vehicle projects by carrying out fabrication of light alloy structures which have some commonality with air-frames. The ISRO-HAL cooperatve programme started with hardware fabrication for ISRO launch vehicles, SLV-3 and ASLV, structures for satellites, Aryabhata, Bhaskara and APPLE. These jobs were undertaken by HAL both at its Kanpur and Bangalore divisions. With the growth of activities in ISRO over the years, the need to create a dedicated facility at HAL was felt essential and an ISRO-HAL joint study was undertaken in 1984 to assess the infrastructure needed for handling the enhanced workload of ISRO. Based on this study the facility and manpower requirements were finalised and an exclusive facility, the Aero Space Division (ASD), was established.

While HAL has made available 26 acres of land and skilled man-power to the new facility, ISRO has provided the necessary funds for civil works, machinery and equipment. ISRO has also assisted HAL in technology acquisition and procurement of equipment.

PSLV heatshield under inspection

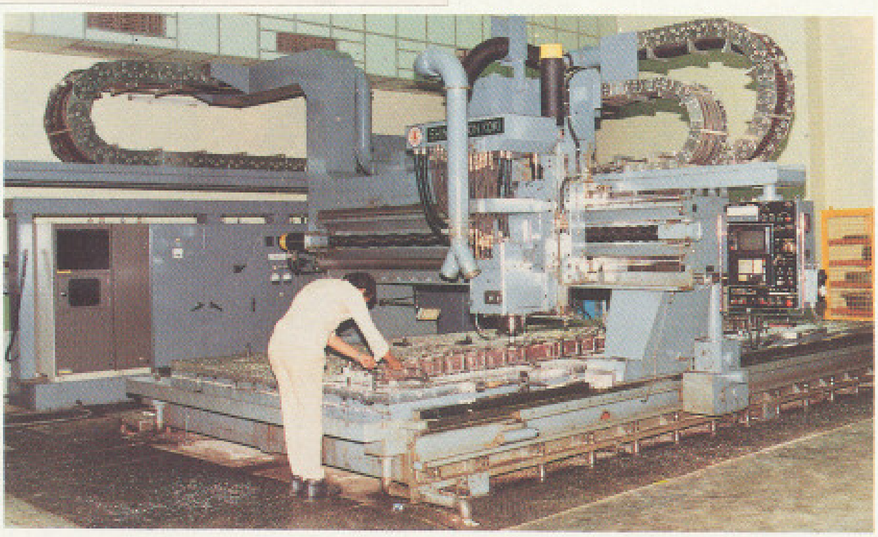


PSLV inter-stage 1/2L



Pocket milling of Iso-grid panel for PSLV heatshield

PSLV strap-on nose cones



CNC router

ASD is now the biggest work centre in the country rendering hardware fabrication support to ISRO programmes.

The facilities at ASD include CNC and general machine shop, assembly shop, welding and heat treatment shop and a process shop. The CNC machine shop houses five CNC vertical Turn Mill Centres with turning capacity ranging from 1.6 m to 4 m diameter jobs, mainly intended for machining various types of rings. One CNC router can machine Iso-grid panels of size upto 5500 mm X 2500 mm. The light machine shop accommodates smaller and general CNC machines including a CNC jig-boring machine. In addition to aluminium alloy structures, these machines cater to machining of titanium alloy forgings (for the PSLV fourth stage propellant tank).

There are two assembly shops, one with a roof height sufficient to accommodate tall structures including the 10 m PSLV heatshield main assembly which is the tallest of PSLV light alloy structures, and the other shop for smaller structures.

The welding shop caters to the requirements of the PSLV liquid propellant tanks which are welded out of chemically milled alluminium alloys. This shop has machinery for sheet metal works, welding sets, welding fixtures, heat treatment furnaces, non-destructive test equipment, helium leak test facility, etc. This facility can handle tanks upto 4 m diameter.

The process shop has facilities for anodising (chromic acid process), chemical milling and electroplating. This shop is one of the largest of its kind in Asia.

In addition to the above, administrative and engineering blocks, bonded stores and canteen have also been built as part of the ASD facility. The total area covered by the various shops and offices is about 26,000 square metre.

ASD has been carefully planned to utilise the infrastructure available in the country and to avoid costly duplication. The quality of the products delivered by ASD is ensured through quality supervision by HAL and ISRO. The facilities created at ASD are capable of meeting the requirements not only of the ASLV and PSLV but also of the GSLV.

ASD was set up in just 30 months through the combined efforts of ISRO and HAL teams. It is a standing example of ISRO's policy of not only maximising the utilisation of Indian industrial infrastructure but also of upgrading and modernising such infrastructure. ◘

Water tank for second stage of PSLV

COSPAS - SARSAT Joint Committee meeting held in Bangalore

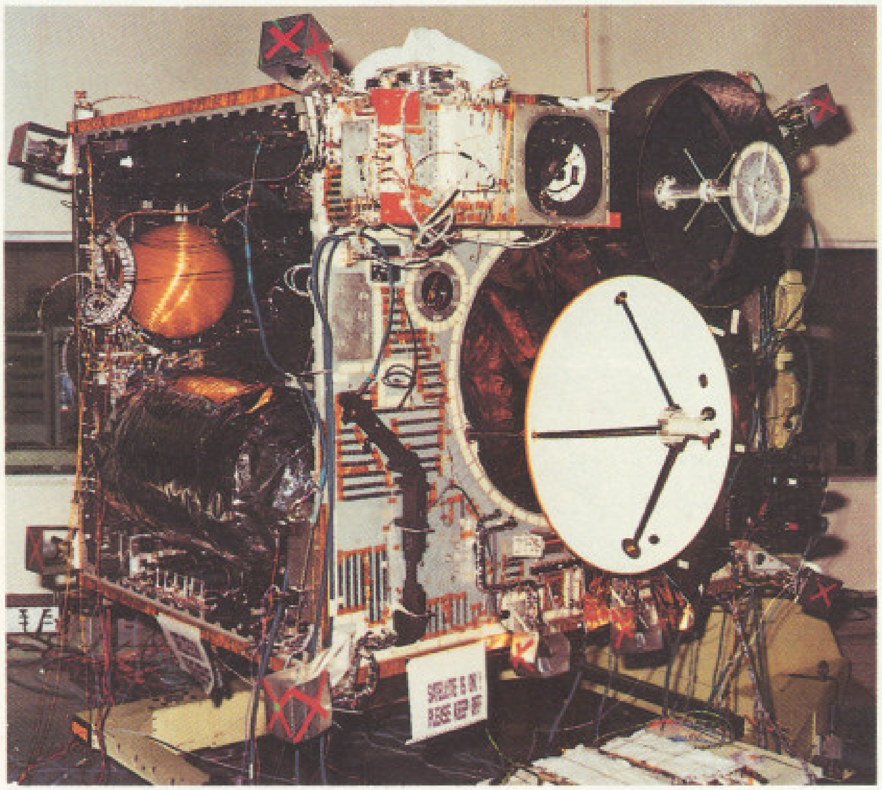
The Joint Committee (JC) of the International COSPAS-SARSAT programme has always been held at the Headquarters in London. This year, however, an exception was made and the meeting (the fifth, in the series) was held in Bangalore during September 9-18, 1991 at the Hotel Ashok Raddison. Hosted by India, the Joint Committee (JC-5) meeting was inaugurated by Prof.U.R.Rao, Chairman, Space Commission. Over 90 delegates from 22 countries attended the meeting.

COSPAS-SARSAT is an international satellite-based system for Search and Rescue (SAR). The International COSPAS-SARSAT Programme Agreement was signed in 1988 by the Governments of Canada, France, USA and USSR. Many countries have formally joined the Programme since then. The Programme is managed by COSPAS-SARSAT Council through its Secretariat located at the Headquarters of INMARSAT in London. The Council is assisted by the Joint Committee (JC) which advises the Council on all technical and operational activities under the Programme. The JC meets periodically to review the system status, future plans, changes in operational procedures due to new entrants, etc.

The space segment of COSPAS-SARSAT system consists of a series of polar orbiting satellites. Ground stations spread over the globe receive the distress alert signals transmitted by emergency beacons through the spacecraft, process them and pass on the location information to a Mission Control Centre for initiating rescue. The actual rescue action is taken by the maritime, aviation and land authorities of various countries throughout the world. An active participant in this international programme, India has established two Local User Terminals (LUT), at Bangalore and Lucknow, to receive distress alert signals from COSPAS/SARSAT satellites. The Indian Mission Control Centre (MCC), located at Bangalore collects, validates, merges, transmits and stores the data from LUTs and other MCCs and exchanges the data within the COSPAS-SARSAT system (see Space India 2, 3 & 4, 1989). India also provides the alert services to the neighbouring countries in the Indian ocean.

The participants of the JC committee visited the ISRO Satellite Centre (ISAC) and ISRO Telemetry, Tracking and Command Network (ISTRAC) facilities, including the COSPAS-SARSAT, MCC and LUT at Bangalore. ▫

INSAT-2A Flight Model integration begins



INSAT-2A Flight model integration in progress

The integration of the Flight Model of INSAT-2A, the first indigenously built satellite in the second generation INSAT-2 series, has begun at ISRO Satellite Centre (ISAC), Bangalore. The integrated spacecraft test is expected to take place during the first week of November this year after which the spacecraft will undergo thermovac tests at ISAC for about three weeks. Subsequently, the appendages like antennas, solar panels and solar sail, will be integrated and the spacecraft will undergo acoustic tests.

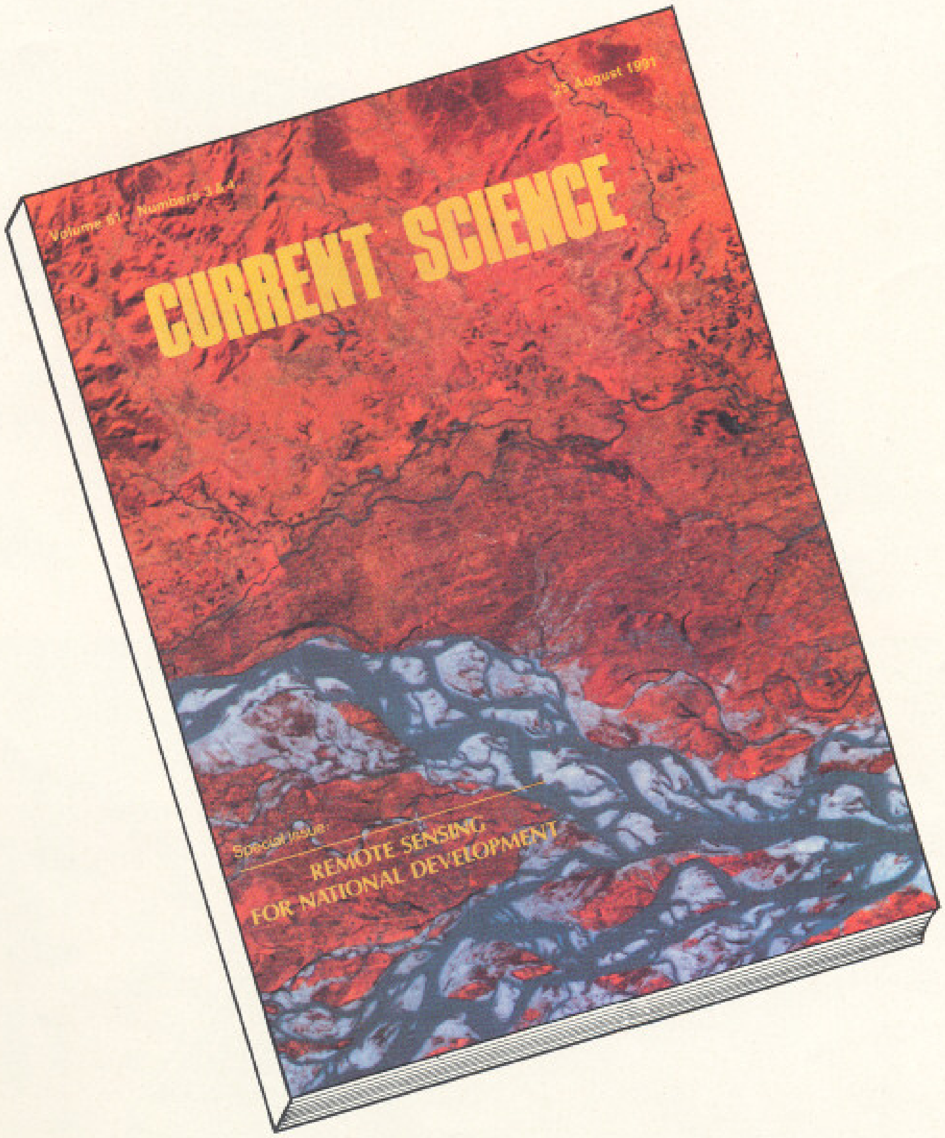
INSAT-2A is slated for launch from French Guyana on board the Ariane Vehicle of ESA during March 1992. ¤

Corrigendum

ISRO develops composite materials for Dentures
(Space India, January - March 1991)

The development of a reinforced polymer for fixed prothodontics was a project initiated originally by the Dental College, Thiruvananthapuram with grant of funds from Kerala State Committee on Science Technology and Environment. The product was developed by the collaborative efforts of the Composites Group of VSSC, Thiruvananthapuram and the Dental College, Thiruvananthapuram. Composite Group of VSSC, Thiruvananthapuram has played a key role in the development of process, design and the characterisation of the composite materials, and final selection of composites, viz. KEVLAR-PMMA for application in fixed prosthodontics. The compatibility and toxicologic studies, development of the moulds and the product for final application, clinical trails, etc., were carried out by the Dental College, Thiruvananthapuram. ¤

Current Science Special Issue on Remote Sensing



On the eve of the launch of IRS-1B satellite, the fortnightly multidisciplinary journal, Current Science, has brought out a special issue on 'Remote Sensing for National Development'. (Current Science, Vol. 61, Nos. 3 & 4, 25 August 1991)

Copies can be obtained from:

Circulation Department
Indian Academy of Sciences
C.V.Raman Avenue, P.B.No.8005
Bangalore - 560 080, India.

Price per copy: India Rs.150

Abroad US $ 20 (including postage).

Thrust frame assembly for PSLV fabricated at HAL, Bangalore