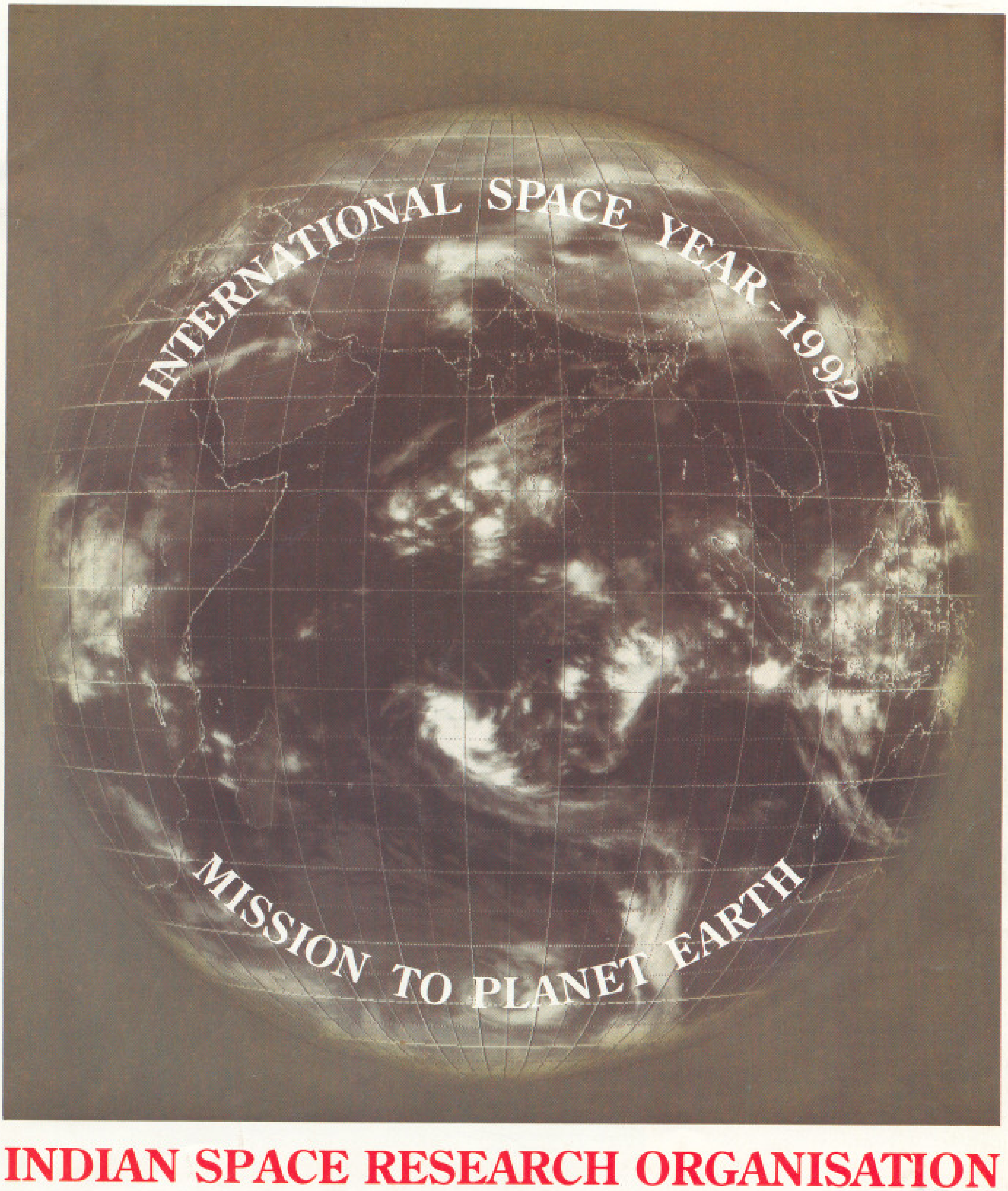
OCT. 1991 - MAR. 1992

SPACE india



INDIAN SPACE RESEARCH ORGANISATION

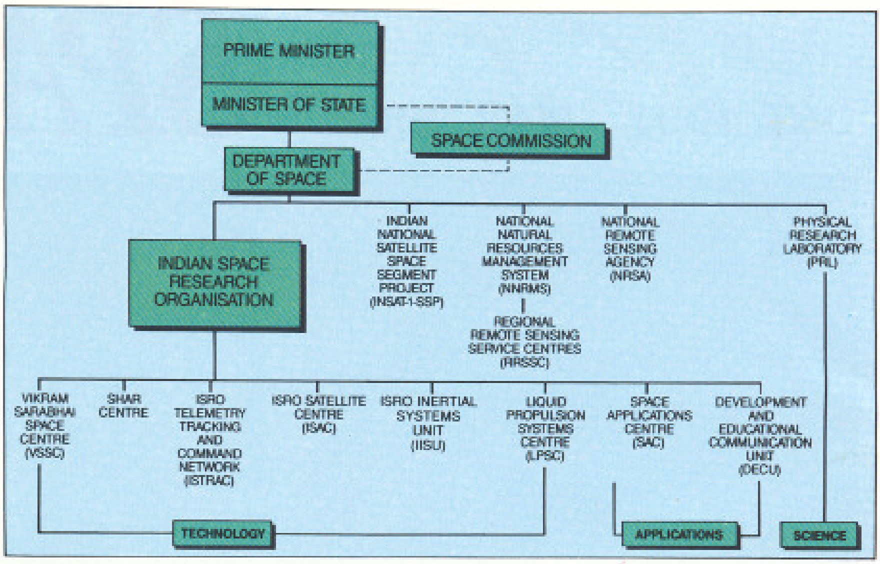
The Indian Space Programme

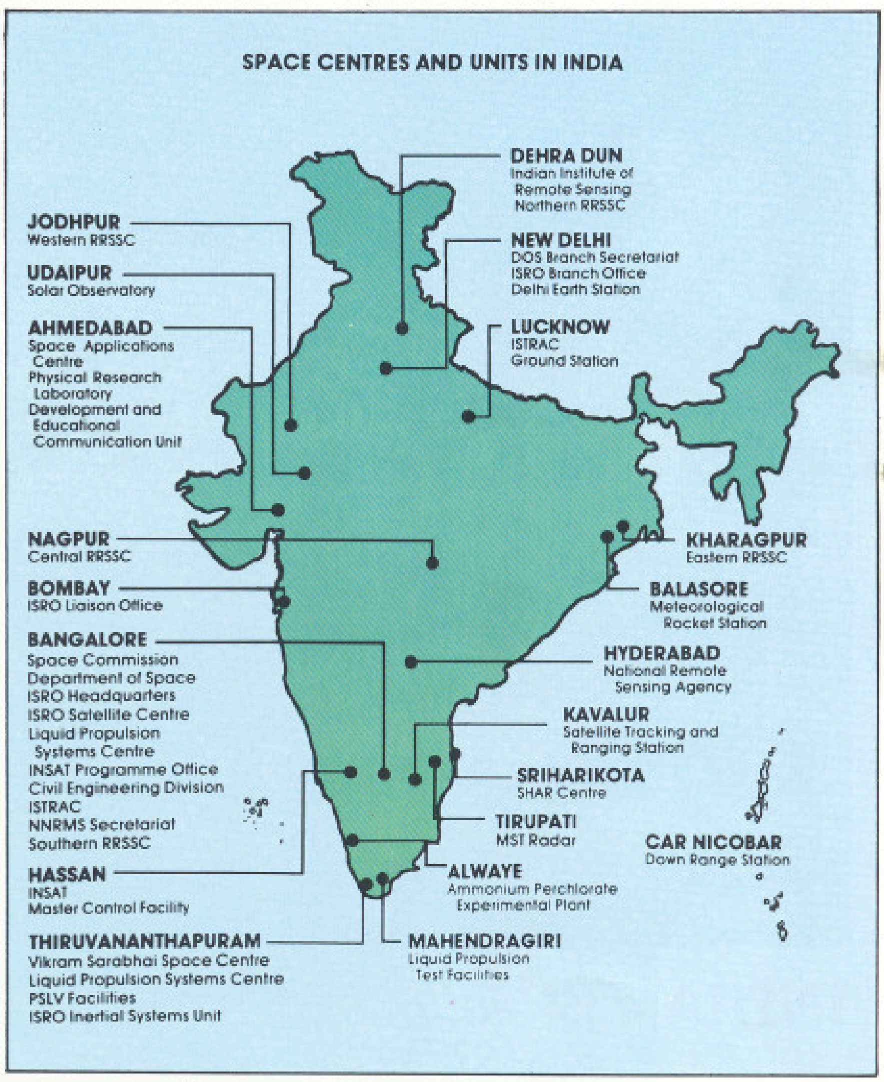
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science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

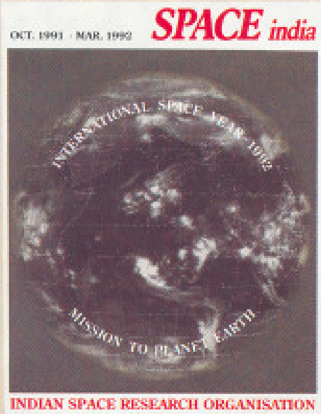
The Indian Space Programme is directed towards the goal of self-reliant use of space technology for national development, its main thrusts being: (a) satellite communications for various applications, (b) satellite remote sensing for resources survey and management, environmental monitoring and meteorological 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
INSAT-1 VHRR Imagery

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Contents

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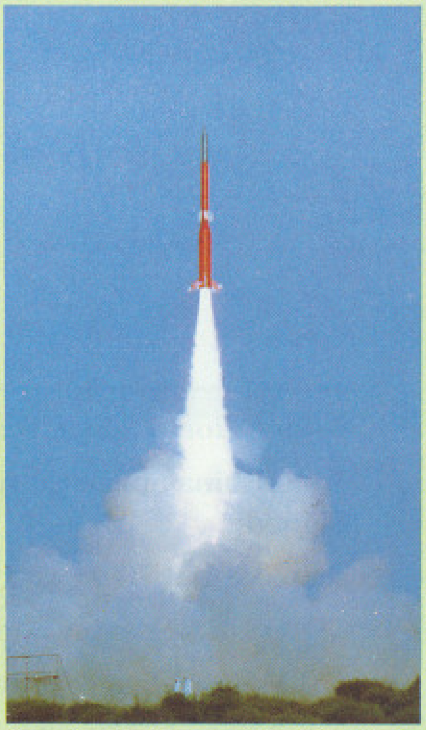
International Space Year-1992

A fundamental human instinct is to explore the Universe. It is perhaps this instinct that impelled Christopher Columbus, exactly 500 years ago, to set sail in search of a new world. Since then, man has set his foot not only on almost every part of this planet but also much beyond on the moon. His footprints will be seen, in the next few decades, on the Martian soil and other planets. While the exploration of our own planet has been continuing for the past few centuries, the possibility of going beyond earth and looking at it from space had remained a dream until the first Sputnik was launched 35 years ago in 1957. Since then, there has been rapid progress in space exploration with Yuri Gagarin becoming the first man in space on April 12, 1961 and, within that decade Neil Armstrong and Edwin Aldrin landing on moon in July 1969. Space stations, space walk, deep space probes and space shuttles which were mere fantasies once, have all become realities today. Though space technology started primarily with the objective of scientific exploration, over the last three decades it has also made significant impact on man's daily life. It has provided satellites for communications, TV and Radio broadcast, meteorology, resources survey and management apart from those for continuing scientific exploration.

Nothing comes free in this world, least of all technological and industrial progress. No doubt, man has achieved tremendous progress in almost all fields of human endeavour, but at a heavy price. The fragile space-ship known as planet earth is under severe stress, the green canopy is disappearing at an alarming rate, the rainfall has become erratic and uneven leading to unprecedented floods and



Sounding Rocket experiment for atmospheric studies

drought, acid rain is becoming wide-spread, ozone—the ultra violet sheath protecting the life on earth—is depleting fast, drinking water is becoming scarce, the greenhouse gases are increasing in concentration and even the air we breathe is becoming unbearably polluted, in short, the very life on the blue planet is under threat!

All of which means that it is high time we took a holistic view of things and planned our development strategy while protecting, preserving and restoring (wherever we have already inflicted damage) the pristine beauty of mother earth. There can be no nobler theme than this for the celebration of ISY-1992. Hence the significance of the mission to planet earth.

The International Space Year–1992 (ISY) was first proposed in 1986 by Senator Spark Matsunaga of Hawii, in the US Congress. The initiative called for a year of globally coordinated space efforts–from space missions to classroom activities and public exhibitions–in order to increase awareness and appreciation of space programmes at both professional and public levels. The year 1992 was specifically selected because it is the 500th anniversary of Christopher Columbus 'Voyage to the New World'. It is also the 35th anniversary of the International Geophysical Year, which ushered in the era of human exploration of space using the space probes and satellites. Thus the celebration of ISY will highlight the themes of both exploration and discovery.

Formal planning for ISY started in August 1987, when 150 delegates from eight spacefaring nations and the European Space Agency met in Hawaii to propose specific programmes for this purpose. Since then, space agencies including NASA, private aerospace companies, and international scientific organisations have established ISY planning committees to figure out themes and general plans for a global celebration. A consensus has been reached among all the planning groups that ISY be celebrated as a one-year event sustaining public interest; the scientific content will include planning for activities extending over many years.

The first definitive theme put forth for ISY was 'Mission to Planet Earth'. This theme was developed in the spring of 1988 at a planning conference in New Hampshire, USA. Delegates included senior scientists from around the world who prepared recommendations for earth observation for ISY. In addition to the scientific planning, senior space agency officials also participated in a special session on

A Balloon ready for launch for trace gas measurements

overall ISY planning. Seventeen space agencies joined together to form a Space Agency Forum on International Space Year (SAFISY) and agreed to meet periodically to share ideas and pool resources for the celebration of ISY. This coalition has grown to twentynine space agencies and has adopted, as one of its main themes, the NASA proposal, Mission to Planet Earth. Space organisation of 24 countries, besides ESA and EUMERSAT, are members of SAFISY. Ten international organisations are also represented here. SAFISY, of which ISRO is a member, is coordinating the participation of different space agencies in ISY. SAFISY has three panels of experts, one each on Earth Science and Technology, Education and Applications, and Space Sciences. The Space Science panel of SAFISY, through the Committee on Space Research (COSPAR) under International Council of Scientific Unions (ICSU), has evolved several space science projects that use computer network to expand public involvement in space missions.

The 44th session of the United Nations (UN) General Assembly adopted a resolution (44/46) on December 8, 1989, to designate the year 1992 as International Space Year (ISY), with the central theme "Mission to Planet Earth", to focus mainly on a) management of natural resources of the earth and of environment, b) longterm education programme and c) public education.

Accordingly, the UN will encourage all countries, particularly the developing ones, not only to participate in the application of space technology but also to undertake programmes that could contribute to the understanding, management and the safeguarding of the global environment.

The UN, as part of ISY, will be organising an international conference on 'Satellite remote sensing for resources management, environment assessment and global change studies' in cooperation with US, during 1992. A regional workshop on 'Application of space techniques to combat natural disaster' is being organised by UN in cooperation with Government of China. UN is proposing to establish centres for space science and technology education in existing national/regional educational institutions in Africa, Asia and Pacific, Latin America and the Carribean and Western Asia. A global telecast of a panel discussion on Mission to Planet Earth by distinguished experts with facility for the audience to ask questions is also planned.

Many countries are contributing in different ways to the success of ISY programme.

A 25 year long programme of NASA, Mission to Planet Earth, with international participation, is aimed at finding solutions to problems such as ozone depletion, global warming and acid rain. Under this programme, NASA will launch, Earth Observation System, comprising a fleet of 4 polar orbiting spacecraft later this decade. This will provide continuous and near simultaneous coverage of the earth's hydrological cycle, biochemical cycle, climate and geophysical processes.

ISY in India

India as a member of the SAFISY has played an active role in formulating various proposals for ISY. In tune with the spirit of ISY, India proposed an undertaking of a cooperative mission called "Protection of Environment for Assuring Cleaner Earth" (PEACE). The programme envisaged realisation of a remote sensing project including launching of environmental satellites through international co-operation involving both developing and developed countries. The proposal attracted an indepth discussion during the SAFISY meeting at Frescati, Italy, during May 2-3, 1989.

As Vice-President of the International Astronautical Federation, India has an active role in the organisation of the World Space Congress in Washington during August - September 1992. An important contribution of India to the ISY is its participation in the International Geosphere, Biosphere Programme, (IGBP), initiated by the International Council of Scientific Unions. IGBP aims at understanding the interactive physical, chemical and

Major International ISY Programmes

February 10 - 13, 1992: ISY-92 conference on earth and space science information systems at Pasadena, California, USA

March 30 - April 14, 1992: European ISY-92 Conference at Munich, Germany

April 27 - May 1992: UN/US ISY-92 Conference on Satellite Remote Sensing and Global Change Studies at Boulder, Colorado, USA

June 1992: Asia Regional Seminar on Tropical Eco-Systems at Thailand.

June 21 - September 30, 1992: UN/ISY Exhibitions 'The Home Planet' at UN Headquarters, New York, USA

August 2 -14, 1992: International Society for Photogrammetry and Remote Sensing Congress, Washington, USA

August 1992: "Where Next, Columbus?" Exhibition at National Air and Space Museum, Washington, USA

August 28 - Sep 5, 1992: World Space Congress at Washington, USA

August 25 - 30, 1992: Pacific Ocean Remote Sensing Conference at Okinawa, Japan

October 1992: Polar Stratospheric Ozone Workshop at Bonn, Germany

November 16 - 20, 1992: Asia Pacific ISY Conference at Tokyo, Japan

The World Space Congress, being held in Washington during August 28 to September 5, 1992, will be the most significant event to mark the International Space Year. The Congress, dedicated to Discovery, Exploration and Cooperation, will be a historic gathering of space scientists, engineers and policy makers. The Congress is being organised by the American Institute of Aeronautics and Astronautics (AIAA), National Aeronautics and Space Administration (NASA) and the United States National Academy of Sciences. It will combine for the first time, the biennial plenary meeting (29th) of the Committee on Space Research (COSPAR) and the Annual Congress (43rd) of the International Astronautical Federation. Over 3000 papers are expected to be presented during the Congress spread over nine days. The Congress will provide a forum for review of many cooperative projects initiated by SAFISY and the latest results and issues in the areas of space science, engineering, law and policy for future space programme.

To enable wider participation from developing countries, a workshop "Space Technology for Developing Countries – Making It Happen" is being jointly organised by UN, IAF, and AIAA just prior to the IAF Congress. It will be attended by many scientists from developing countries. The workshop is being arranged at the specific initiative of the IAF Committee for Liaison with the International Organisations and Developing Nations (CLIODN) for which Prof. U.R. Rao is the Chairman. Followed by the workshop, CLIODN is organising a series of special lectures from experts from different developing countries on topics such as Space and Education, Safety and Rescue, Satellite Communications, Global Change and Relevant Space Observations and Earth Observations.

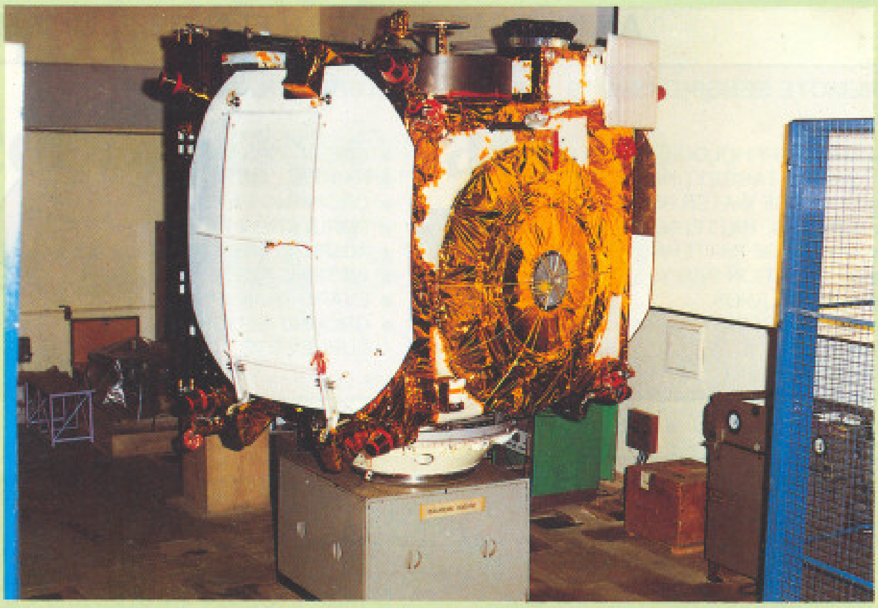
An exhibition spread over 1,00,000 sq.ft. representing advanced space and technology concepts is also being organised as part of the World Space Congress.

biological processes that regulate the total earth system and its unique environment to sustain life; it also explores the anthropogenic effects on environment. India has set up a number of facilities including space-based observation systems such as IRS, INSAT for the study of global changes. Major programmes have been undertaken for the study of changes in forest cover, vegetation index, albedo, marine productivity, soils, hydrology, etc. India will also be conducting studies in climate modelling, atmospheric minor constituent and aerosols, and land-air-ocean interactions using ground, balloon and space-based experiments.

The initiation of sustainable integrated development at micro level through a network of development projects spread over 21 selected districts in different parts of the country is another major programme under ISY. It calls for judicious use of natural resources and emphasises the need for conservation at micro level taking into account the likely impact of the global changes on productivity. Locale specific prescriptions for development at micro level will be arrived at through the use of space-based remote sensing data combined with other collateral socio-economic data using geographic information systems.

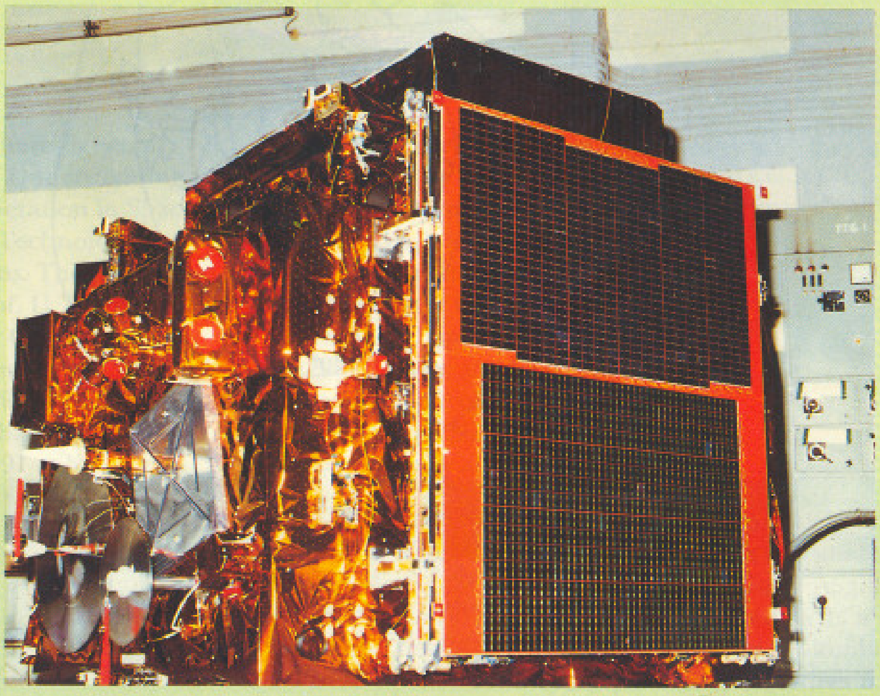
In the field of public education, the proposed GRAMSAT, a unique space-based system, dedicated for eradication of rural illiteracy and for providing continuing education to special social groups and industrial workers, will go a long way to sustain the ISY interest beyond 1992.

It is rightly said that instead of bequeathing a legacy of prosperity, peace and progress to our grand children, we have already borrowed time and resources from them! An example is the rate at which we are consuming non-renewable energy resources like oil; further, by accumulating toxic



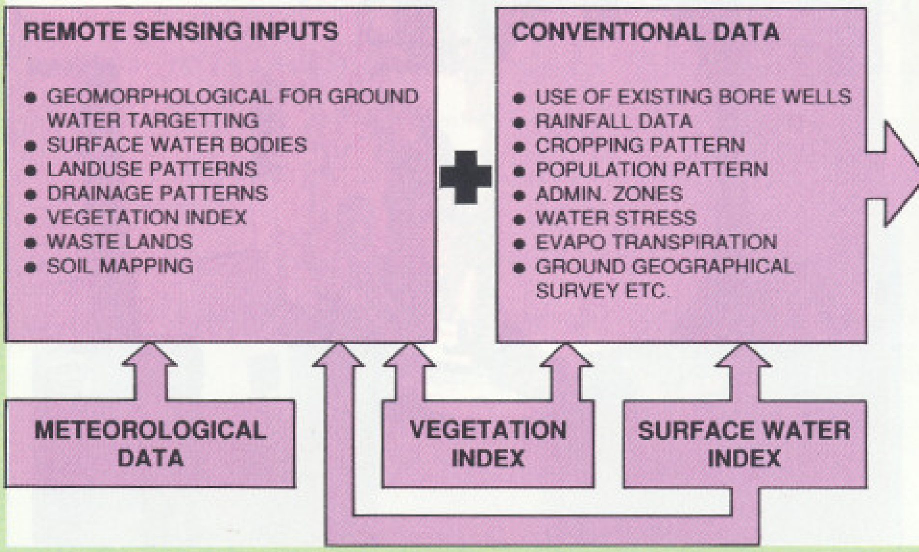
INSAT-2A planned to be launched in June 1992

Antenna array for MST Radar at Tirupati

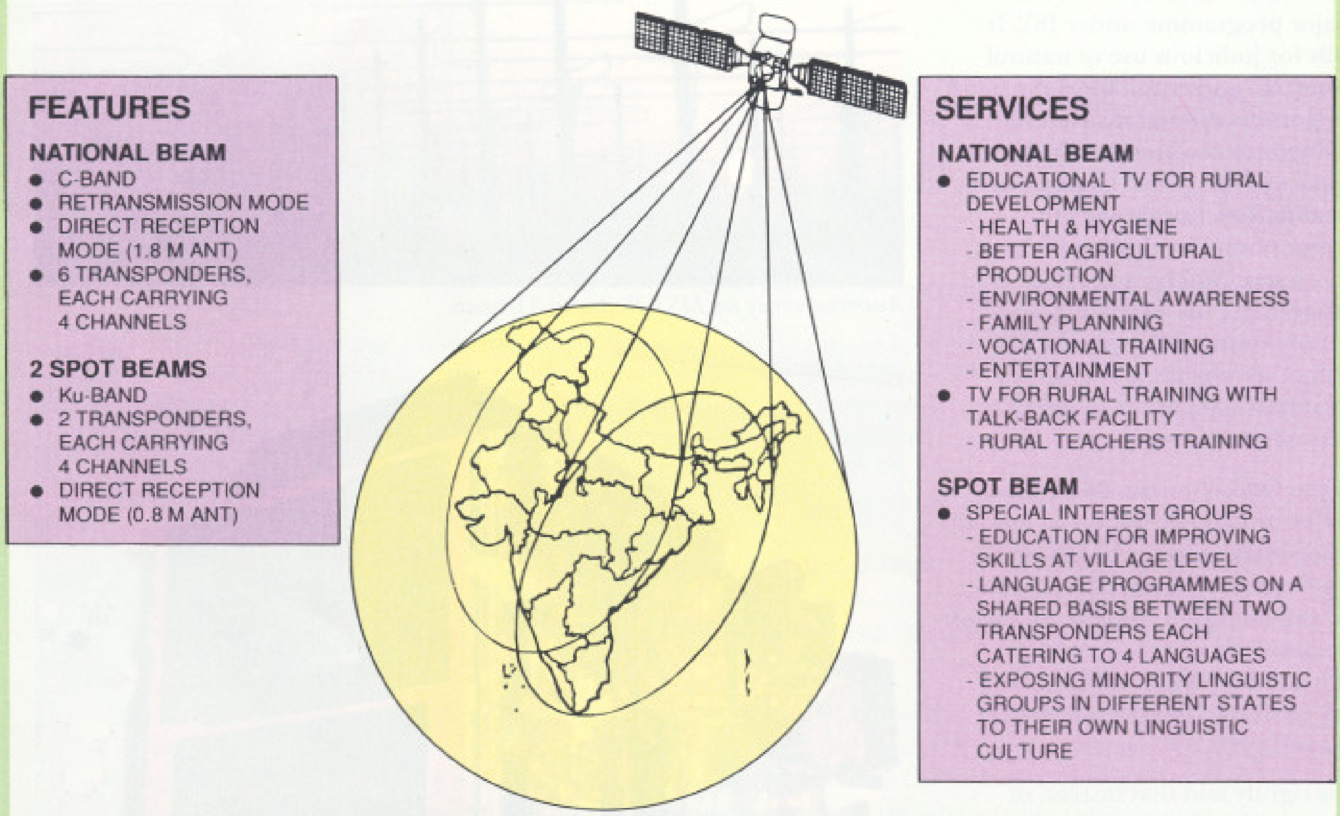


IRS-1B launched in August 1991

AN INTEGRATED PLAN FOR DROUGHT MITIGATION



GRAMSAT CONCEPT



materials like nuclear waste, we are making this mother-earth a dangerous place to live. The irony of it all is that we do have technology to solve most of the problems facing us today. For example, space technology can play, as it does even today, a crucial role in detecting, monitoring and even in prudent exploitation of our natural resources. It is, therefore well within our hands to reverse the present trend of mindless exploitation of our planet and use the various forums being organised during the ISY to focus attention on how to achieve sustainable development through benign but efficient technologies that are nature-friendly'. □

Indo-China Space Cooperation Agreement Signed

India and China have signed a Memorandum of Understanding for bilateral cooperation in Space Research, Space Technology and Space Applications. The agreement was signed by Prof. U. R. Rao, Chairman, Space Commission, on behalf of Government of India and Mr. Liu Jiyuan, Vice-Minister for Aerospace on behalf of China on December 13, 1991 at New Delhi in the presence of Prime Minister of India, Shri P.V.Narasimha Rao, and Mr. Li Peng, Prime Minister of China.

The agreement is based on successful completion of a number of high level discussions held between the Department of Space, Government of India and the Ministry of Aerospace, China. Earlier, a high level delegation from China visited the Vikram Sarabhai Space Centre at Thiruvananthapuram, ISRO Satellite Centre and Spacecraft Control Centre of ISTRAC at Bangalore and National Remote Sensing Agency at Hyderabad.

Being two large developing nations, the two countries stand to gain considerably by cooperation in a frontier technology like space in which both have made remarkable progress in the recent years. □

Satellite Data for Crop Protection

Cotton crop affected by white fly

Through detection of conditions favourable to the proliferation of pests and assessment of damages caused by them, satellite remote sensing plays an important role in the protection of crops. It is also possible to study the distribution of the principal host plants or habitats of pests, environmental factors favourable for spreading of insects and diseases.

Crop losses can be due to biotic factors like pests, diseases and weeds or due to abiotic factors like drought, flood, cyclones and hailstorms. Damage caused by pests can result in either overall reduction in the yield or change in colour, offensive odour, etc., reducing the net value. The magnitude of the problem in our country can be gleaned from the fact that the annual loss due to pests is about Rs 5,000 Crores (average of 1953-87 data) which is much higher than the combined loss due to drought (Rs 1,500 Crores) and flood (Rs 770 Crores). The plant protection measures encompass quarantine regulations, determination of economic thresholds of pests, epidemiology, life cycles of pests and understanding of the ecological conditions in the agro-eco system. Satellite remote sensing can provide useful information on most of these factors. It is especially useful for quick, repetitive and synoptic observations.

Disease and pest problems are more severe in tropical than in the temperate zones. Mono-cropping and collateral hosts enable perpetuation of pests. Heliothis armigera, an insect pest of pigeon pea (tur), can increase its population dramatically if irrigated crops are available. In Andhra Pradesh, for example, irrigated tomatoes, which were virtually unknown a few years ago, are now regularly grown during each dry season and Heliothis armigera utilises these plants as a new host and builds up its population and attacks various other crops in the ensuing Kharif season. Another example is the brown planthopper, a major pest only in the cooler rice growing countries of Asia, namely, Japan, China and Korea till recently, has become a major threat to rice crop in India as well since 1970, when cultivation of high yielding, irrigated rice varieties became popular. Monsoon and typhoons also help in the dispersal of pests over large areas. Monitoring the weather systems and the change in agro-eco systems, therefore, is necessary to provide the farmers with pest resistant cultivars so that sole reliance on pesticides is avoided. It is in this context that the role of satellite remote sensing is to be perceived as a potential tool in the overall control of crop pests and diseases.

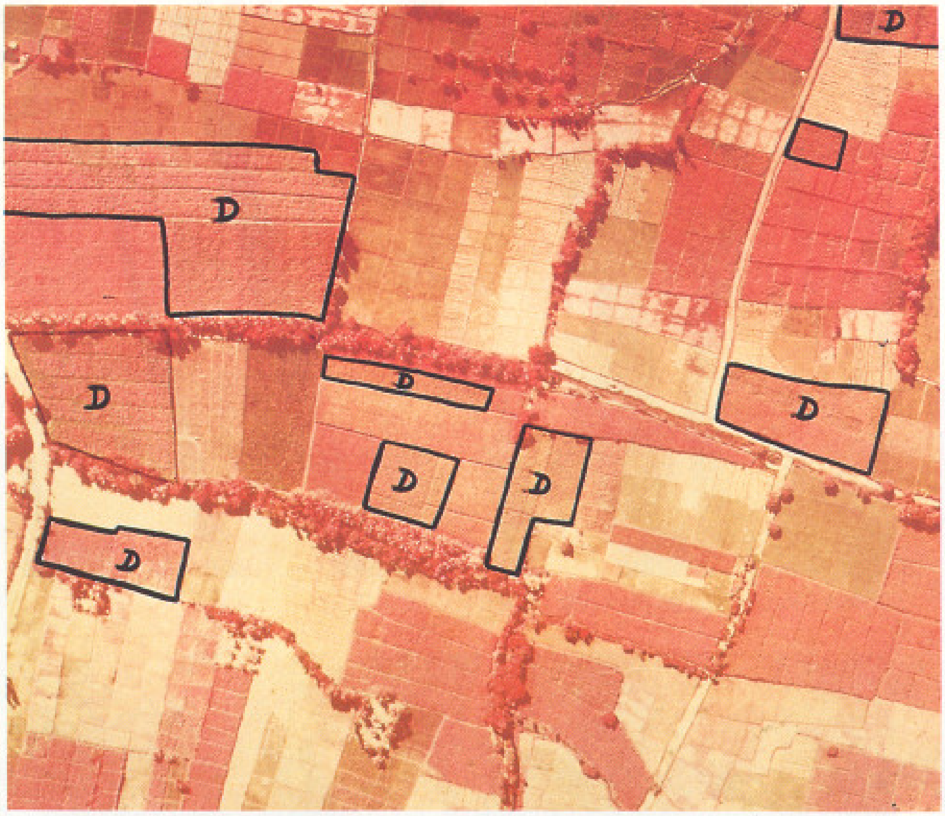
An understanding of the physical and physiological properties of plants and their interaction with incident radiation is important in crop condition assessment through remote sensing. The plant leaves have both diffuse and specular characteristics. The diffuse leaf reflectance emanates primarily from the interior of the leaf through multiple scattering. The specular character of leaf reflectance at the surface of the leaf is primarily affected by the topography of the cuticular waxes and leaf hairs. Decrease in infrared reflectance is one of the earliest symptoms of reduction in vigour in many plants. During drought, the spongy and palisade mesophyll cells become flaccid resulting in reduction in the infrared reflectance. In the case of fungal infection, the leaf air space may be invaded by fungal hyphae, further reducing the infrared reflectance from the leaves.

Brown Planthopper on Rice crop culms

Coconut fronds infested by Coconut Black headed caterpiller

For effective utilisation of remote sensing for plant protection, it is necessary to measure the changes in spectral reflectance and emission so as to identify the crop type and the pest/pathogen responsible for the damage. Extraction of information from remotely sensed data is carried out either through visual interpretation or computer-aided image processing. Identification of crops is done through a photo interpretation key developed using a combination of tone, texture, pattern and knowledge of crop calendars and farming operations. Spectral pattern recognition techniques are used to study reflectance characteristics (spectral signatures) of crops and damage caused by pests. Satellites provide timely and repetitive information on symptoms which are often transient and closely linked to different phases of crop growth.

In India, work on the application of remote sensing techniques in plant protection began with the coconut wilt disease detection experiment in Kerala in 1969. Helicopter based multiband photography indicated the feasibility of identification of different plant species and



Colour Infrared photo of Sugarcane crop affected by Helminthosporium

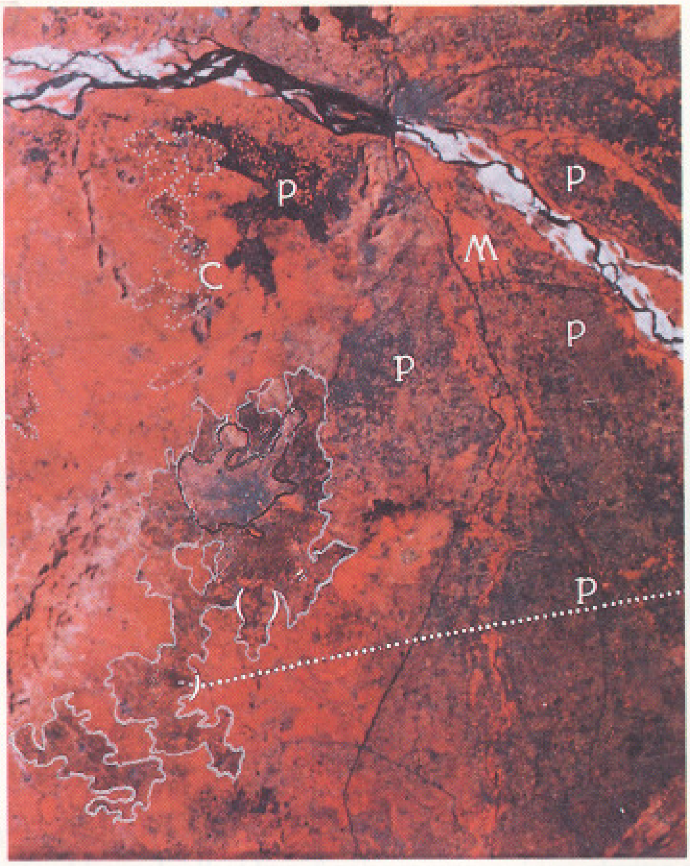
detection of coconut wilt. Airborne multiband and multitemporal photography on a 1:60,000 scale around Mandya in Karnataka during the 70s was found promising in the identification of sugarcane crop affected by leaf-blight. During 1980-84, under the Joint Experiments Programme with Indian Council of Agricultural Research, ground-based sensors were used to evaluate many parameters related to remote sensing systems and the plant-soil-atmospheric continuum. Work on application of remote sensing in plant protection and crop production forecasting has been intensified using the Indian Remote Sensing Satellites, IRS-1A and IRS-1B data, with the participation of many central and state agencies.

The desert locust which is endemic over Rajasthan, Gujarat and Haryana, is part of the world recession area. An improved desert locust forecasting system is being evolved by the Locust Warning Organisation using the facilities available at Regional Remote Sensing Service Centre (RRSSC), Jodhpur. This will help save time and resources by pinpointing the potential breeding areas.

Epidemics of wheat rust over the Indian subcontinent are influenced by western disturbances and the depressions that pass over the southern hills (Nilgiri and Palani Hills). Phytopathologists have shown that the paths of transport of wheat stem rust uredospores are associated with the movement of visible stratus-type clouds from Nilgiri and Palani hills to Central and North India. The daily cumulative cloud cover monitored by weather satellite can be used as an index to provide early warning on occurrence of diseases. Regular monitoring helps in predicting an epidemic about 20-25 days before the first appearance of the disease on crops. In a project carried out jointly by Indian Agricultural Research Institute (IARI) and ISRO, satellite data collected during two years (1978 - epidemic year and 1977 - normal year) have been analysed using computer aided techniques to detect changes in the wheat growing region of West Punjab affected by yellow rust epidemic.

In 1985, the summer rice crop in the Bhadra command area in Karnataka, covering about two lakh acres and valued at about Rs. 40 crores, was damaged by the brown planthopper (BPH). Similar damages of rice crop in many parts of the country have occurred in the past (Godavari delta in Andhra Pradesh in 1981; Gobichettipalyam in Tamil Nadu in 1975; Kuttanad and Kole area in Kerala in 1974). The satellite remote sensing technology can be used as a monitoring system to secure the implementation of cropping rules that can help in taking control measures against the BPH. In view of the high spatial resolution data now available from IRS-1A and IRS-IB, it is possible to monitor the conditions favourable for BPH attack on rice.

Satellite derived false colour imageries have been used for the assessment of cotton crop condition. Areas of moderate (50 per cent crop loss) and severe (80 per cent crop loss) damage by the white-fly have been easily



Satellite imagery showing cotton crop affected by white fly

identified. The damaged crop area estimated from the satellite data was found to be close to that of the area reported by the Directorate of Agriculture to within 12 per cent. Remote sensing techniques could be used i) to implement the legislative enactments to stop continuous cotton growing in a specified area, ii) to demarcate areas requiring crop rotation, iii) to monitor the time of harvest of cotton so as to break the life cycle of the pest, and iv) to estimate the acreage under alternate hosts (tomato, chilli, tobacco, etc.) for assessing the carry over potential of the pest in the off season.

Preliminary investigations have been carried out on area estimation and health assessment of orange plantations using IRS-1A data at the Regional Remote Sensing Service Centre, Nagpur. The data has been used to delineate diseased and healthy stock. The area under diseased orchards accounted for 5 per cent of the total area of the orange plantation. A more extensive project for mapping and monitoring the health of orange orchards has been takenup jointly with the National Centre of Citrus Research in India, at Nagpur.

Thus, the feasibility of satellite based remote sensing in monitoring the growth and spread of plant diseases and pest infestation in terms of their overall effects on crop vigor and development has now been established. This encouraging start points to a promising future in effectively tackling the pests and diseases that are taking a heavy toll of our crops every year. □

'Antariksh Bhavan' - Headquarters of ISRO at Bangalore

ISRO-IISc.

The Indian Space Research Organisation (ISRO) and the Indian Institute of Science (IISc.), Bangalore, have recently signed a protocol for collaborative research in advanced space technology. It was signed at a simple function held at IISc. by Prof. U.R. Rao, Chairman, ISRO and Prof. C.N.R. Rao, Director, IISc. on March 31, 1992.

The protocol is a follow-up to the Memorandum of Understanding (MOU) signed between the two organisations in June 1982 under which a Space Technology Cell (STC) was set up at IISc. to carry out research exclusively in the areas of space science and technology relevant to the Indian space programme. Over the last ten years, a number of such research projects have been successfully completed at STC. Under the present protocol, ISRO and IISc. will jointly establish an Advanced Space Technology Laboratory at IISc. to carry out frontline research in several critical areas of space science and technology. ISRO is funding the laboratory under its Sponsored Research Programme (RESPOND).

Since the setting up of ISRO in 1972, IISc. has been actively contributing towards the implementation of many ISRO programmes. The linkage between the two became more formal with the initiation of IISc.-ISRO Educational Programme (IIEP) in 1977. The success of IIEP led to the establishment of the STC at IISc. in 1982 to tackle multi-disciplinary problems encountered in space technology. Starting with a modest programme of collaborative research in 1983, the activities of the STC have grown steadily over the past decade encompassing the following:

* Sponsored Research Projects
* ISRO-IISc. Educational Programme (IIEP) in Space Science and Technology
* Visiting Scientists Programme and
* Technical Publications

So far, 72 ISRO sponsored research projects have been taken up by IISc., including 46 sponsored through STC. Under IIEP, 98 seminars have been held and 52 workshops conducted on various space science and technology related subjects. Fourteen short term courses have also been organised.

ISRO has sponsored 72 of its scientists for attending post-graduate and doctoral courses at IISc., apart from 46 ISRO scientists under the external registration programme.

Prof. U. R. Rao (right), Chairman, ISI
exchanging the documents

Space Cooperation

Indian Institute of Science, Bangalore

The research projects taken up at STC address a wide range of problems - both in the fields of fundamental research and technology development. Many of these projects are handled jointly by the faculty of IISc. and the scientists of ISRO.

Some of the projects undertaken in the area of propulsion and propellants include high frequency combustion instabilities in liquid propulsion systems, development of nozzleless propulsion technology, air-breathing propulsion devices, liquid propellant slosh studies, studies on catalytic decomposition of mono-propellants and investigation of hypergolic ignition of biliquid and hybrid propellants.

...nd Prof. C. N. R. Rao, Director, IISc.,

In the field of polymers and composites, the research projects include development of new organometallic and metal-containing polymers, characterisation of polymers for different applications, study of composites for use as structural components, development of new methodologies for analysing composite laminates and study of the indentation behaviour of layered metals like copper and steel.

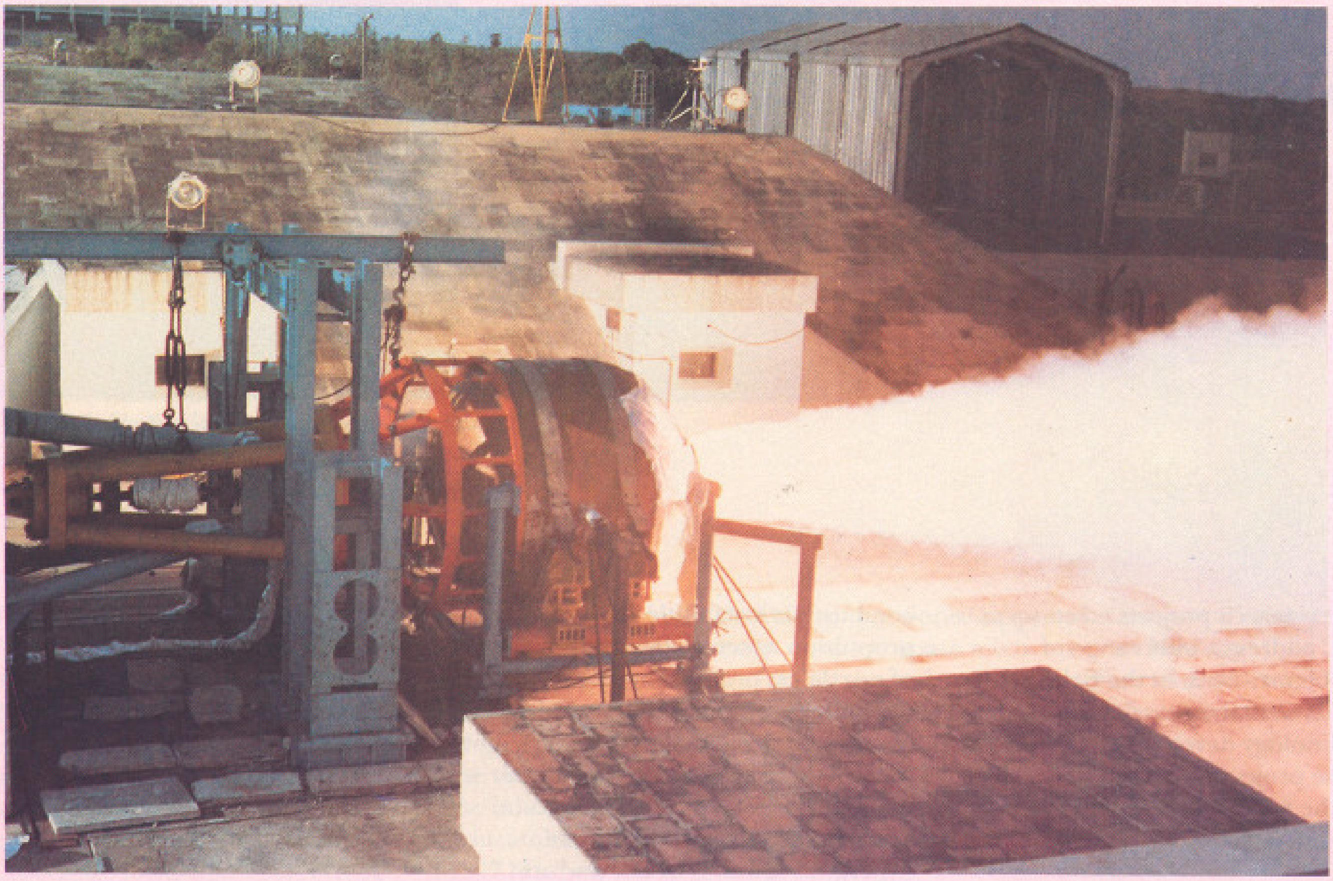
Laminar and turbulent flow, heat transfer and combustion studies are the projects undertaken in the area of fluid mechanics and heat transfer.

In the area of orbital mechanics and controls, preliminary orbit determination, interaction of control and structural dynamics of satellites are some of the studies conducted.

Computer classification of remotely sensed data, simulation and experimental studies on fibre optic system and development of special instruments for aerospace application have also been undertaken under this collaborative programme.

Besides strengthening the ties between the two institutions the protocol is expected to provide a fresh impetus to research in five specific areas - cryogenics, composites and materials, propulsion systems, aerodynamics and signal processing. □

PSLV Third Stage Motor



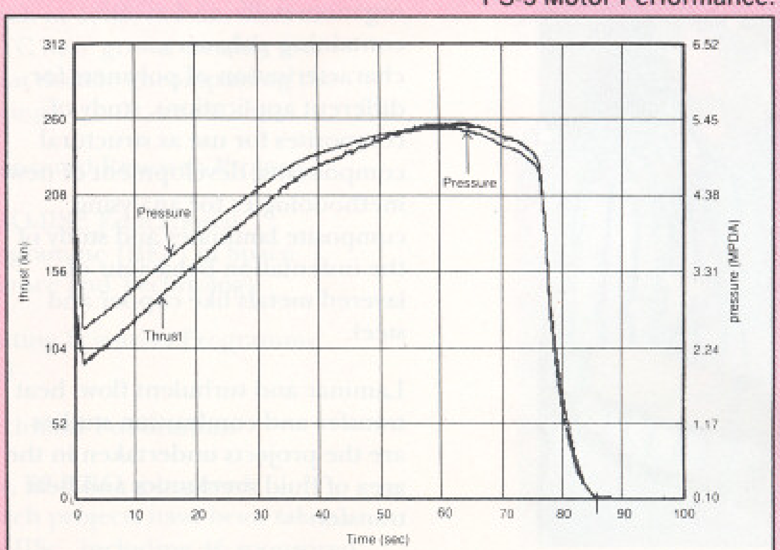
PS-3 under static test at SHAR Centre

A milestone of PSLV project was crossed with the successful static testing of the high energy third stage solid propellant motor, PS-3 at SHAR Centre, Sriharikota on October 17, 1991. Analysis of test data has indicated normal performance of the motor. This was the sixth static test of the motor. The previous test conducted successfully on July 29, 1991 had validated the igniter and nozzle interfaces and the overall motor and component systems performance. The main objectives of the sixth test were:

a) to evaluate the flex seal and modified thermal boot performance for vectoring,

b) to confirm the performance of

PS-3 Motor Performance.



motor-nozzle and motor-igniter interface, and
c) to qualify the motor for flight.

The PSLV third stage motor is two metre in diameter and 2.3 metre long and carries about 7 tonnes of Hydroxyl Terminated Poly-butadiene (HTPB) propellant. It's poly aramid (Kevlar) motor case is the largest developed by ISRO. The motor is also the largest one using HTPB propellant composition and the first ISRO motor with a submerged nozzle.

The motor, designed and realised by VSSC, is made out of 9 layers of polar winding and 20 layers of hoop winding using a Kevlar epoxy system. For the production of the motor case, weighing 320 kg, a novel method of making a sand mandrel for winding the motor case was used. The case has aluminium alloy end bosses and an inter skirt ring made of a hybrid Kevlar/carbon cloth system.

The rocasin insulation system is laid in-situ and cured in an autoclave. The HTPB propellant system has 86 per cent solid loading using the resin produced at VSSC. The PEDCOAT liner which is used as an interface between insulation and the propellant was also developed by VSSC. The propellant was cast at SHAR Centre, using vertical mixer and the motor was cured at a pressure of 3 KSC.

The pyrogen igniter has HTPB-based propellant and a fibre glass igniter case. The pyro chain consists of igniter, 2 safe/arm units and explosive transfer assemblies (ETA).

The sixth static test on PS-3 motor at SHAR Centre was preceded by an integrated test in which control system and motor case was characterised at different pressures.

The repeatability of ballistic performance of the motor during two successive static tests has cleared the way for preparation of the flight motor. □

PS-3 Motor case

PS-3 static test bed at SHAR Centre

Salient Features

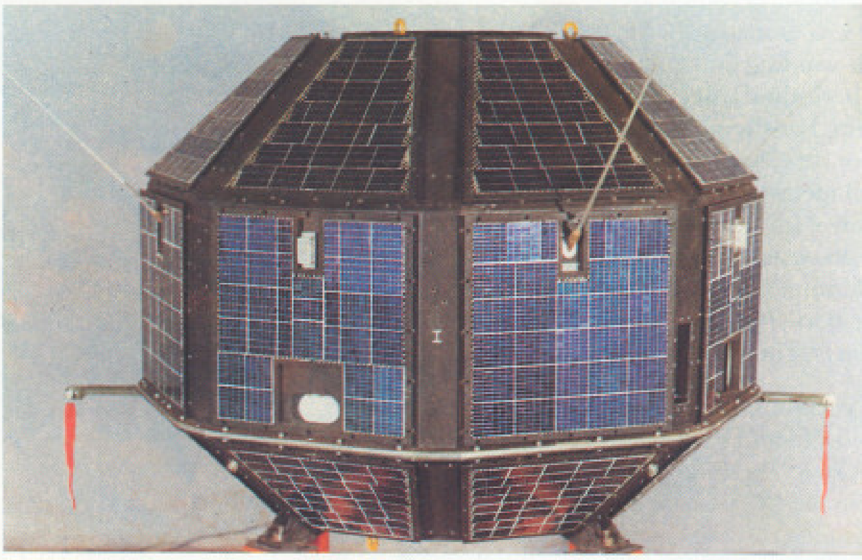
Overall length (mm)	: 2442.0
Maximum diameter (mm)	: 2006.0
Case	: Kevlar epoxy composite
Propellant	: HTPB-based
Propellant weight (kg)	: 7293
Nozzle	: Submerged flex type
Area ratio of the nozzle	: 12.3
Igniter	: Pyrogen type
Burn time (s)	: 73.1
Action time (s)	: 78.3
Maximum pressure (MPaa)	: 5.819

Aryabhata and Bhaskara-II End their Sojourn in Space

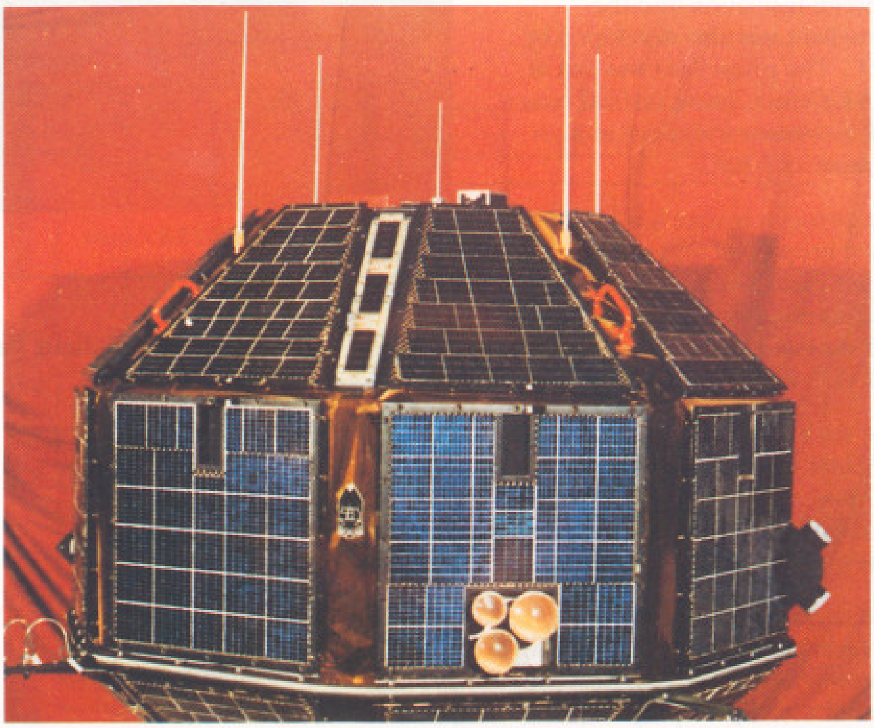
The first Indian satellite, Aryabhata, launched on April 19, 1975, re-entered atmosphere on February 10, 1992 after being in orbit for almost 17 years. The signals during Aryabhata's 92,875th orbit, the last around the earth, were received by the Sriharikota ground station of ISRO Telemetry, Tracking and Command Network (ISTRAC), at 1827 hours Universal Time (UT) for a duration of about 30 seconds before the satellite became silent.

Aryabhata was launched on board the Soviet Intercosmos rocket from the USSR into an initial 619 x 562 km orbit with an inclination of 50.64 deg. The primary objectives of the Aryabhata mission were (a) to indigenously design and fabricate a space-worthy satellite system and evaluate its performance in orbit; (b) to evolve the methodology of conducting a series of operations on the satellite in its orbital phase; (c) to set up ground-based telemetry, tracking and telecommand systems; (d) to establish infrastructure for the fabrication of spacecraft systems. All these objectives were more than met by Aryabhata before the end of its designed operating life of six years. The satellite also carried three scientific experiments in X-ray astronomy, solar physics and aeronomy.

Aryabhata was being tracked from Sriharikota ground station regularly even after its six-year operating life. Towards the end of



Aryabhata



Bhaskara-II

its stay in orbit life, intensive tracking was carried out and its re-entry date calculated using ISRO developed computer programme, taking into account the predicted solar flux values which play an important role in the orbital decay of satellites. The re-entry date, predicted as on January 2, 1992, was February 13, 1992. The

ocean, forestry, hydrology, water and land masses.

Bhaskara-II experiment was important in that it paved the way for developing the operational Indian Remote Sensing Satellites, IRS-1A and IRS-1B, which are in service today. Bhaskara-II was last tracked by the ISTRAC at 0715 hours UT on November 30, 1991. □

Message from Prof. U.R. Rao, Chairman, ISRO

The momentous event of Aryabhata re-entering the atmosphere on February 10, 1992, after 17 years of operation since its launch in 1975, brought back all the nostalgic memories of India's first satellite project. Aryabhata not only ushered in the era of indigenous satellite technology in India, but also was responsible for building a young, energetic, dedicated, enthusiastic and, above all, a highly committed core team of scientific and technical personnel in ISRO, who have now been able to bring satellite technology to the international level. Personally, I feel proud to have led this trail blazing team which, starting from scratch, working day and night inside the asbestos roofed sheds with practically no infrastructure, had to conceive, design, fabricate and test a satellite, in an incredibly short time of just over two and a half years. In retrospect, it is clear that we owe our achievements in the satellite technology today, to the dedicated team involved in the Aryabhata mission.

It is appropriate on this occasion to rededicate ourselves to the spirit and dedication of those pristine days of Aryabhata.

U.R. Rao

Prof. U.R. Rao was the Project Director for Aryabhata

prediction was refined with further updating of the data and on February 7, 1992 the predicted re-entry date was February 10, 1992 at 2130 hours UT. The final re-entry occurred exactly on this date at 1829 hours UT. Space agencies in other countries were also tracking the satellite till the last orbit.

Bhaskara-II

One of the early Indian experimental remote sensing satellites, Bhaskara-II, launched on November 20, 1981, re-entered earth's atmosphere on November 30, 1991. The 440 kg satellite, launched by the USSR on board an Intercosmos rocket, carried a two-band TV camera system and a three-frequency passive microwave radiometer system. The satellite was successfully used for more than two years for conducting remote sensing experiments related to

Yagi antenna at SHAR Centre used for Aryabhata and Bhaskara telemetry reception

Awards and Honours

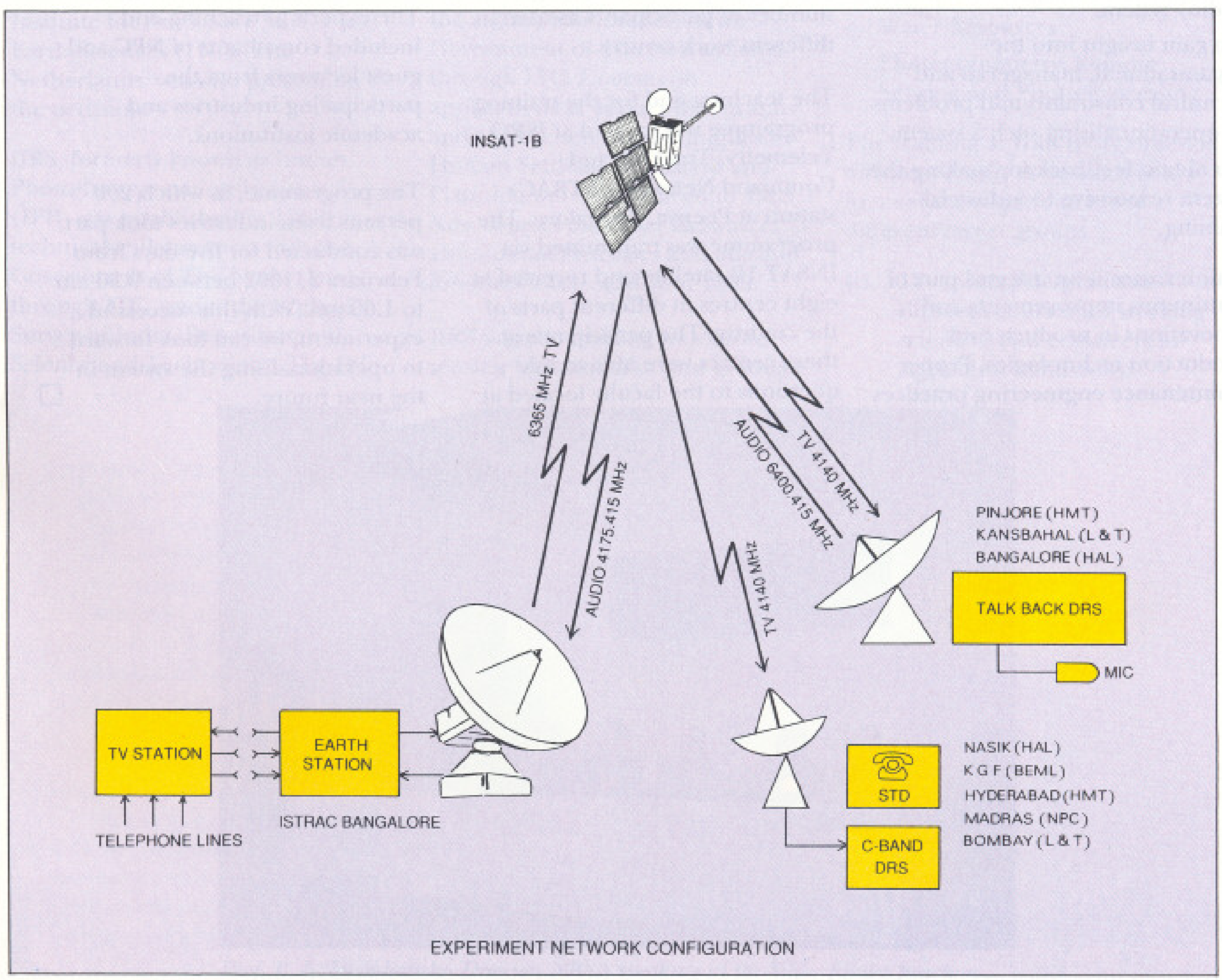
Prof. U. R. Rao, Chairman, Space Commission, has been honoured with the prestigeous Allan D.Emil Memorial Award for International Cooperation in Astronautics by the International Astronautical Federation. The award has been conferred on Prof. Rao in recognition of his outstanding leadership during the last three decades in promoting space technology and applications, particularly in developing nations. The previous awardees include eminent space scientists like Charles Stark Draper of the USA for his Space Inertial Navigation System used in Moon Landing and Academician Oleg. G.Gazenko of USSR for Space Medicine. The award will be presented to him during the forthcoming World Space Congress at Washington, USA, a major programme being organised as part of the celebration of the International Space Year 1992.

Prof. Rao has been championing the cause of developing countries in many international fora. He has been the Vice-President of IAF and the Chairman of IAF Committee for Liaison with International Organisations and Developing Nations (CLIODN) since 1988. Prof. Rao is the first person from Asia to receive this award.

Dr K. Kasturirangan, Director, ISRO Satellite Centre, Bangalore, has been conferred 'Padmabhushan' by the Government of India in recognition of his contribution to satellite technology in the country. Dr Kasturirangan, as the Project Director for Bhaskara I and II and the first operational state-of-the-art Indian Remote Sensing Satellite (IRS-1A), launched on March 17, 1988. Though its design life was only three years, IRS-1A continues to perform well even as it enters its fifth year of operation. IRS-1B, launched on August 29, 1991, has demonstrated indigenous capability for providing uninterrupted operational remote sensing services. The first satellite in the indigenously second generation INSAT series, INSAT-2A, built at ISRO Satellite Centre is now awaiting launch on board the Ariane launch vehicle. The second in the series, INSAT-2B, is in an advanced stage of fabrication. Dr. Kasturirangan's wide ranging technical and scientific knowledge, mature leadership, dedication and innovative management approaches have enabled him to achieve outstanding successes. □

Satellite Communication for Continuing Education in Industry

The Indian Space Research Organisation (ISRO) and National Productivity Council (NPC), jointly conducted an experiment during February 3-7, 1992 to demonstrate the effectiveness of satellite communication for continuing education in industry. The experiment, conducted in collaboration with Bharat Earth Movers Limited (BEML), Hindustan Aeronautics Limited (HAL), Hindustan Machine Tools Limited (HMT) and Larsen & Toubro (L&T), was aimed at updating supervisory skill in maintenance engineering and improving inter-personal relations.



EXPERIMENT NETWORK CONFIGURATION

The experiment was inaugurated by Prof. U. R. Rao, Chairman, Space Commission, on February 3, 1992 at Bangalore.

The fast developing technology in the present socio-economic environment has made continuing education and training in industry essential to and avoid obsolescence. In view of the varied requirement of such training programme, especially when the industries are widely dispersed, satellite communication technology can play a vital role. A satellite-based network has a wide reach, no distance constraints and can provide two-way communication.

The main objectives of the ISRO-NPC experiment were:

– to examine the effectiveness of satellite-based broadcast-cum-interactive (one-way video, two-way audio) system.

– to gain insight into the organisational, managerial and technical constraints and problems in operationalising such a system.

– to obtain feedback for making the system responsive to industrial training.

Maintenance is an integral part of continuous improvements and innovations in products and production technologies. Proper maintenance engineering practices can prolong the life of plant and machinery besides enhancing productivity. Equally important is the human relations. Hence, the significance of the ISRO-NPC experiment. The experiment provided inputs in maintenance engineering and inter-personal relations to the first line Supervisors and Executives.

The training programme was conducted through class room lectures supported by computer-based graphics, pre-recorded case studies of shop floor situations, audio-visual aids and discussions. The discussions were through satellite-based and telephone-based talk-back network. This unique method of distance teaching through a broadcast-cum-interactive network promises to be very useful in compressing learning time as well as in bringing together, a substantially large number of participants located in different work centres.

The teaching-end for the training programme was located at ISRO Telemetry, Tracking and Command Network (ISTRAC) station at Peenya, Bangalore. The programme was transmitted via INSAT-1B satellite and received at eight centres in different parts of the country. The participants at these centres were able to ask questions to the faculty located at ISTRAC station, Bangalore. The centres at Bangalore (HAL), Pinjore (HMT), and Kansbahal (L&T) were equipped with satellite based talk-back system developed by ISRO, while the centres at Nasik (HAL), Hyderabad (HMT), Kolar Gold Fields (BEML), Bombay (L&T) and Madras (NPC) were provided with STD telephone facility for asking questions.

The course topics included Systems Approach to Maintenance, Tribology including Lubricants, Bearings, Failures and Preventive Measures, Non-Distructive Testing, Condition Monitoring, Special Purpose Machine Techniques, Vibration Monitoring, Changing Dimensions of Supervisory Roles, Communication and Inter-personal Relations, Leadership and Team Building, Motivation, Discipline and Grievance Handling.

The experts at teaching-end included consultants of NPC and guest lecturers from the participating industries and academic institutions.

The programme, in which 200 persons from industries took part, was conducted for five days from February 3, 1992 between 9.30 am to 1.00 pm. With this successful experiment, we can look forward to operationalising the system in the near future. □

Indian Institute of Remote Sensing

The Indian Institute of Remote Sensing (IIRS), a premier institution under the Department of Space for training of scientific and technical personnel in the application of remote sensing and photo-interpretation techniques, celebrated its silver jubilee in February 1992. The celebration was inaugurated by Prof. U. R. Rao, Chairman, Space Commission. Dr. Beek, Rector, International Institute for Aerospace Survey and Earth Sciences (ITC), The Netherlands, was also present on the occasion.

IIRS, formerly known as Indian Photo-Interpretation Institute (IPI), was established in 1966, in technical collaboration with the Government of The Netherlands through ITC, under the aegis of Survey of India, Department of Science and Technology. The IPI was brought under National Remote Sensing Agency in July 1976 to meet the growing demands of trained manpower in the application of remote sensing. It was renamed as Indian Institute of Remote Sensing (IIRS) in June 1983.

A new training division "Human Settlement Analysis Group" was formed in 1982 at IIRS, again with the active collaboration of the Government of The Netherlands through ITC. Courses on applications of aerial photographs and remote sensing techniques in Human Settlement Analysis and Planning were introduced in 1983. New courses on Water Resources and Coastal Processes and Marine Resources were added in 1985.

IIRS imparts training in remote sensing techniques at post-graduate level to scientists and engineers in the following areas:

- Agriculture, Soil Survey, Soil Conservation and Landuse Planning
- Coastal Processes and Marine Resources
- Forestry and Ecology
- Geo-sciences
- Urban and Regional Planning
- Water Resources
- Photogrammetry, Remote Sensing and Photo Processing

The training at IIRS is organised at different levels, as detailed below, to meet the requirements of different target groups.

(i) 10-month post-graduate diploma courses for working scientists and engineers in Agriculture and Soils;

Prof. B. L. Deekshatulu, Director, NRSA speaking at the Silver Jubilee function

Forestry and Ecology; Coastal Processes and Marine Resources; Geology and Geomorphology; Urban and Regional Planning and Water Resources.

(ii) Short duration courses, varying from 2 to 8 weeks, on basics of remote sensing and its applications to various disciplines, for middle level supervisory personnel and resource managers.

(iii) One week appraisal and overview course for senior level scientists/engineers and decision makers.

(iv) Short duration technology courses in photography and photo processing.

A view of the Indian Institute of Remote Sensing

The institute has so far trained more than 2,500 scientists and engineers since its inception. They include more than 150 personnel from 25 countries of Asia and Africa, who have been trained under various fellowship programmes including SHARES (Sharing of Experience in Space) programme of the Department of Space. IIRS also provides consultancy services to users. The institute has also put significant efforts towards developing and refining state-of-the-art technology for application of photo-interpretation and remote sensing in different disciplines for undertaking case studies and research projects.

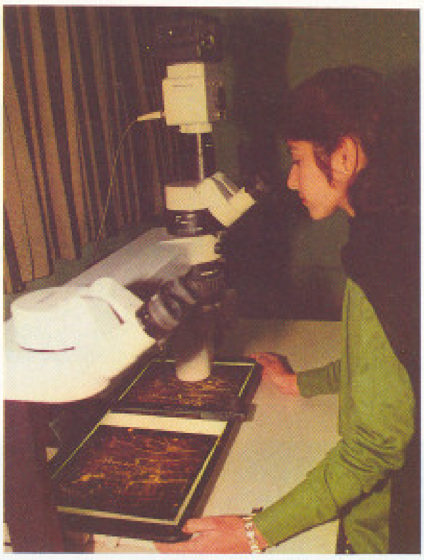
Practical Class in progress

IIRS has taken up many pioneering studies of national interest using aerial photo-interpretation and remote sensing techniques. The important among them are integrated surveys for regional development, soil and land evaluation for irrigation command area, forest inventory in industrial catchment areas, groundwater targetting, landuse surveys for environmental conservation, small format aerial photography for monitoring urban landuse, wildlife habitat evaluation, road alignment studies, geo-technical studies, etc. So far 33 such projects have been completed.

The institute has good infrastructure to meet the requirements of training in the advanced field of remote sensing technology that includes: Photo Processing Laboratory for development, printing, enlargement and rectification of aerial photo and satellite imagery; Photogrammetric Laboratory with Stereo Plotter, Stereocord, Zoom Transferoscope, Optical Pantograph, etc., for thematic and Photogrammetric mapping; Image Interpretation Laboratory with Additive Colour Viewer, Interpretoscope, etc., and a Soil Laboratory for analysing soil sampling. A number of Digital Data Analysis and Geographic Information systems are available. A variety of Ground Truth and Field equipment is also available for making ground based measurements and observations.

IIRS Library has a collection of more than 8500 volumes, Map Library and Image Library.

As part of its Silver Jubilee Celebration, IIRS also organised a two-day seminar during February 18-19, 1992, on Training and Education in Remote Sensing for Resources Management. □



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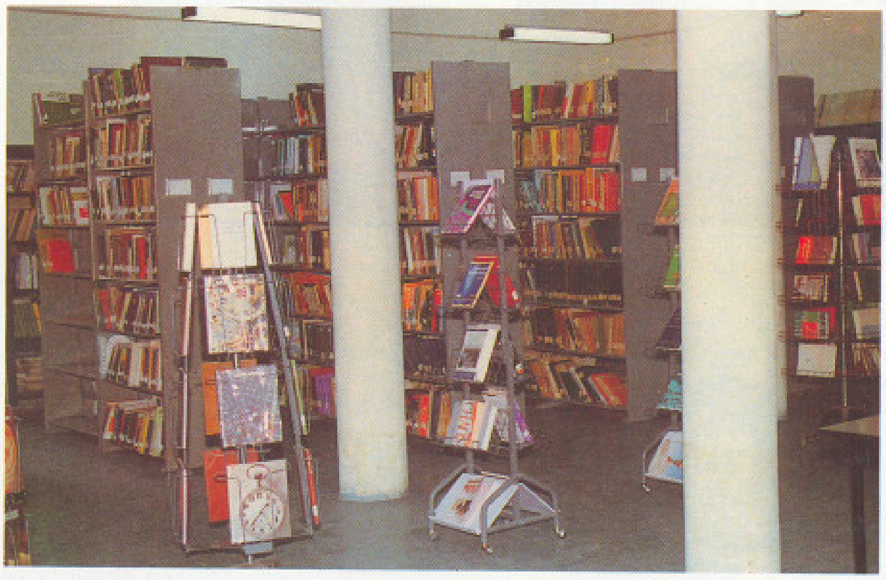
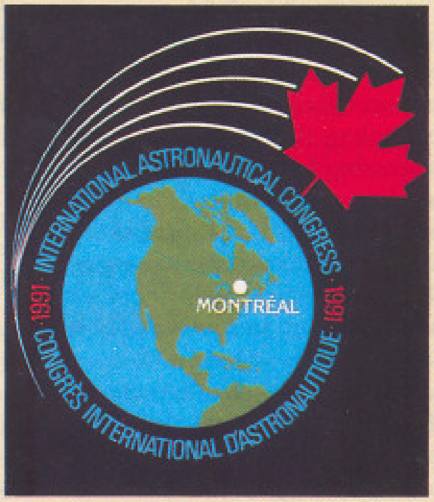
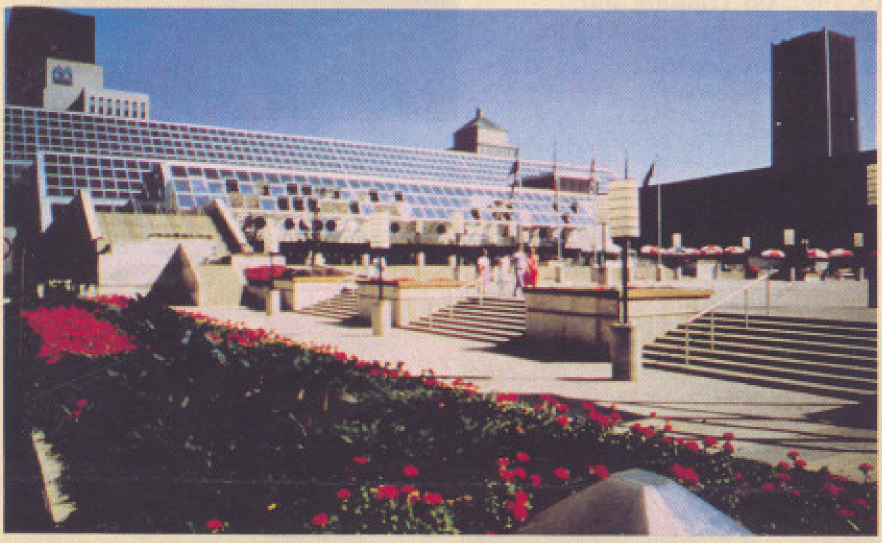


IIRS Library

42nd IAF Congress held at Montreal, Canada





Venue of Congress

The 42nd Congress of the International Astronautical Federation (IAF) was held during October 7-11, 1991 at Montreal, Canada. The theme of the Congress this time was "The Next Century - A Perspective on Space". Since 1950, the International Astronautical Federation has been holding congress every year to provide opportunity for delegates to meet and exchange information and views on all important aspects of space research. The last congress was held at Dresden, Germany. It may be recalled that India had hosted the 39th IAF Congress at Bangalore.

Prof. U. R. Rao, Chairman, ISRO and the Vice-President of the IAF and the Chairman of the IAF body, namely, Committee for Liaison with International Organisations and Developing Nations (CLIODN), led the Indian delegation to the 42nd Congress.

Under the Chairmanship of Prof. Rao, CLIODN has been organising, in the last few years, Special Current Event Sessions during the congress. These special sessions have been addressing priority issues of direct relevance to the developing nations. It has since covered topics like Use of Space Technology for the Benefit of Humankind, Space and Drought Management, Space and Flood Management, and Space and Forest Management. During the 42nd Congress at Montreal, the topic for the special current event session was Space and Agriculture Management. In his overview on this topic, Prof. Rao emphasised the need for an integrated study of land and water resources to sustain the agricultural productivity using space-based remote sensing techniques in conjunction with conventional methods. The discussions also included an assessment of the digital and visual information extraction techniques for agriculture in Argentina, China's experience in the use of satellite data for surveying Loess Plateau, India's experience in the operational utilisation of space based remote sensing for crop yield forecasting, and use of remote sensing for tackling fundamental agricultural problems in Nigeria.

A unique feature of IAF Congress this time was the special UN-IAF-Canada Workshop on Space Technologies for Development held during October 2-5, 1991 at Montreal, Canada, just prior to the congress. The UN, working in close cooperation with CLIODN, is expected to make this a regular feature of the IAF Congress in future. □

Stop-press

INSAT-2A, the first satellite in the indigenously built second generation INSAT series, was air-lifted from Bangalore on April 22, 1992 to Kourou, French Guyana. Its launch on board Ariane is planned during the last week of June, 1992

INSAT-1B completed 100 months in Space in March 1992. The satellite is even now used for conducting various experiments.