Oct. '97 – Mar. '98

SPACE india

INDIAN SPACE RESEARCH ORGANISATION

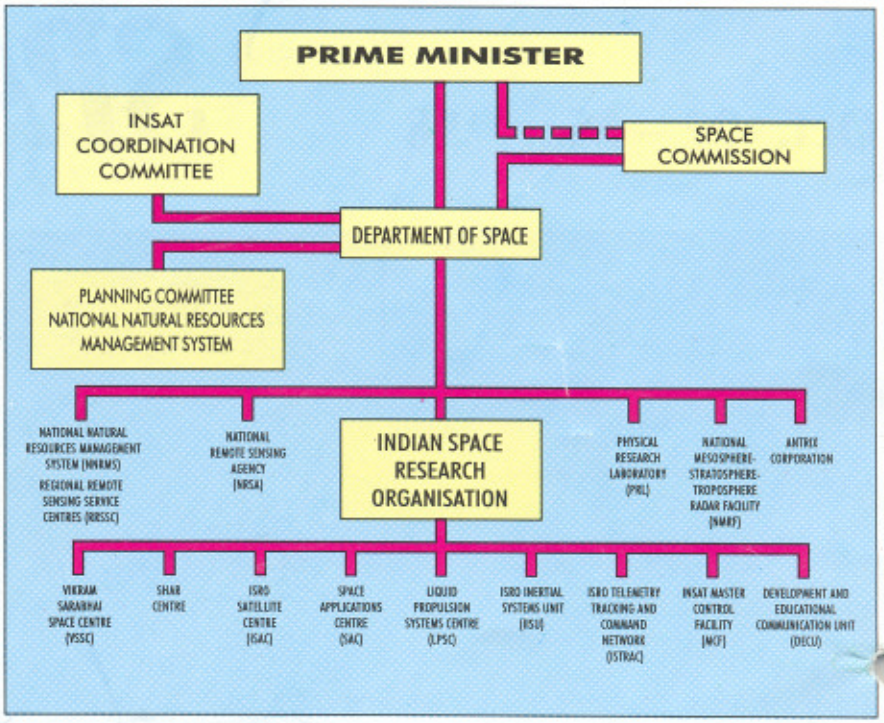
The Indian Space Programme

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 satellite 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 oüt at the Centres and Units spread over the country.



FRONT COVER

IRS panchromatic camera imagery over Ataturk dam on river Euphrates in southeast Turkey. The image was acquired and processed by the Neustrelitz station, near Berlin of Euromap. (Courtesy: Euromap)

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India Signs Memoranda of Understanding for Space Cooperation With USA

The Department of Space (DOS) and Department of Science and Technology (DST) of India signed a Memorandum of Understanding (MOU) with the National Aeronautics and Space Administration (NASA) and National Oceanographic and Atmospheric Administration (NOAA) of USA in Washington on December 16, 1997 for scientific cooperation in the areas of earth and atmospheric sciences. Dr K Kasturirangan, Secretary, Department of Space and Prof V S Ramamurthy, Secretary, Department of Science and Technology signed the MOU on behalf of India and Mr Daniel Goldin, Administrator, NASA and Dr D James Baker, Administrator, NOAA, signed the MOU on behalf of the USA in the presence of Ambassador of India to the US Mr Naresh Chandra. The MOU defines the terms and conditions of scientific and technical collaboration in the areas of earth and atmospheric sciences and exchange of data required for the collaboration. The scientific cooperation envisaged under the MOU includes research and development projects, visits of scientists, organisation of scientific conferences, symposia, courses and workshops, and exchange and sharing of scientific and technological information in the context of cooperative activities.

Dr K Kasturirangan (left) and Mr Daniel Goldin signing the MOU ....

Specific areas of cooperation identified under the MOU include weather analysis and forecasting techniques for various time scales, satellite product development for atmospheric, land and ocean parameters, applications to flood forecasting and drought monitoring and studies of atmospheric constituents. The MOU provides for exchange of data and derived products between the two countries from Indian National Satellite (INSAT), as well as Geostationary Operational Environmental Satellite (GOES) and Defence Meteorological Satellite Program (DMSP) of the US, in near real-time over dedicated telecommunication links to be specially set up between India and the US. With these dedicated links, it will also be possible for Indian scientists to access scientific data available at US Web sites in a much faster mode than at present. Joint research projects using data from the US-Japanese Tropical Rainfall Measuring Mission (TRMM) satellite and the AVHRR data from the US polar orbiting satellites are also envisaged under this programme.

As a follow-up to the signing of the MOU, an Indo-US Workshop on Cooperation in Earth and Atmospheric Sciences was organised by the India Meteorological Department (IMD) during February 10-12, 1998, at New Delhi. Over 50 Indian scientists and 22 US scientists with expertise in various fields of meteorology, climatology and related atmospheric and earth sciences participated in the Workshop

.... and exchanging the documents. Also seen exchanging the documents are Dr V S Ramamurthy and Dr James Baker (extreme right).

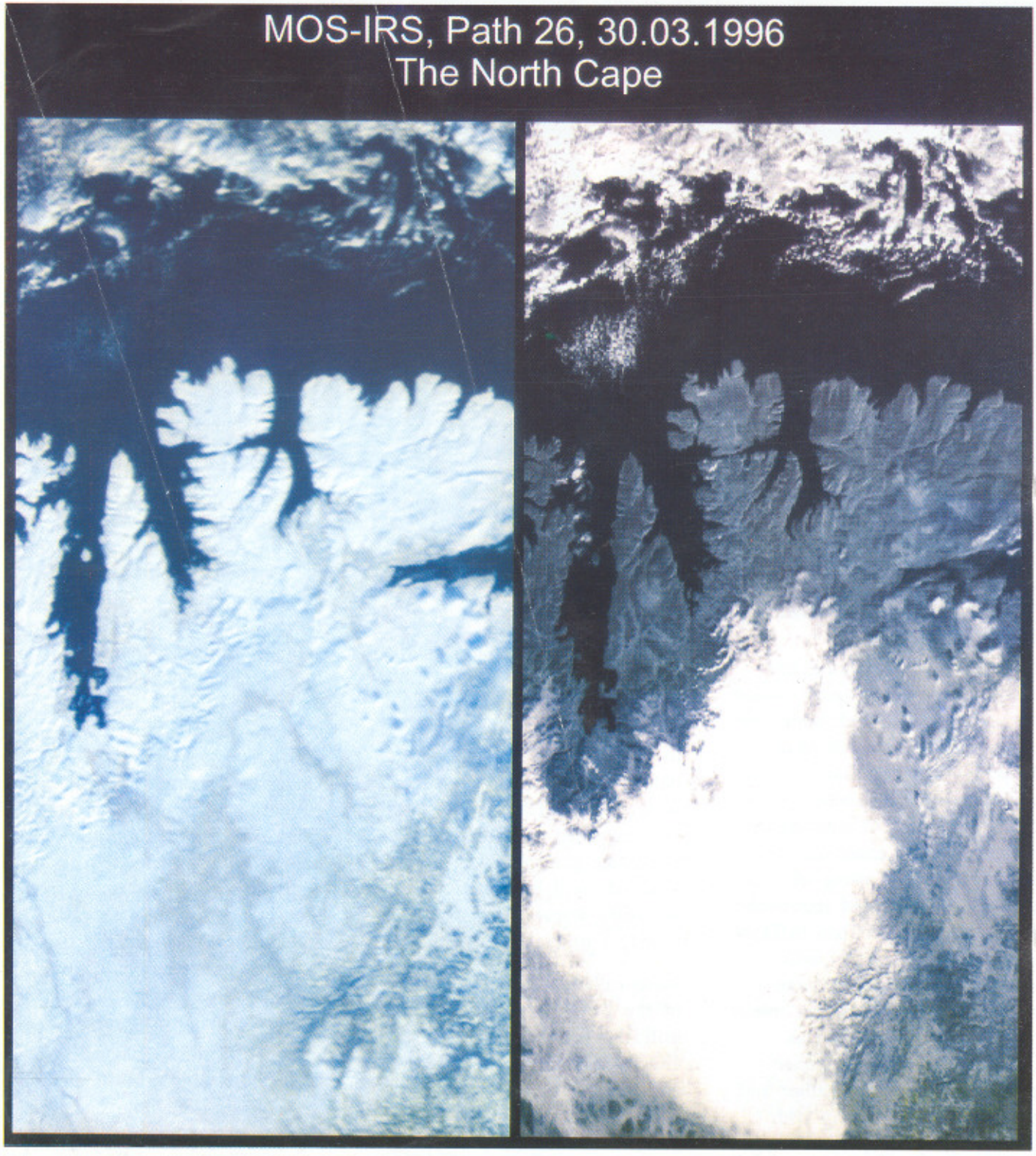
and discussed specific scientific proposals for cooperation in these fields.

IMD has been receiving and processing meteorological image data from the INSAT series of geostationary satellites since 1982 and utilising them for weather monitoring and forecasting. Use of satellite data has particularly enhanced the accuracy of forecasting of tropical cyclones and monsoon rainfall. Scientists from IMD and other agencies in India have been also carrying out advanced research for the use of these and other data as inputs to numerical weather prediction models. Weather and climate are phenomena with global interactions. The linkage of the Pacific Ocean phenomenon called El Nino on the Indian monsoon has recently been reiterated. Under the aegis of the World Meteorological Organisation (WMO) of the United Nations, operational meteorological agencies including IMD have been exchanging data and carrying out studies on different aspects related to weather and climate. Indian scientists studying various aspects of the variability of the south west monsoon, the genesis and movement of tropical cyclones, etc., are keen to obtain global data as well as data over the Indian region from orbiting US satellites. It is also expected that interaction between Indian and US scientists will be beneficial to scientific research in various fields of mutual interest.

Meteorologists in several parts of the world have already been utilising data from the US GOES, the European Meteosat and the Japanese GMS geostationary satellites for numerical weather prediction. They have been requesting at various scientific fora for the availability of the INSAT meteorological data to complete the global inputs required for the models. In May 1995, a team of scientists from NASA/ NOAA visited India and discussed with DOS/DST potential scientific cooperation in the field of earth and atmospheric sciences, including INSAT data exchange, and signed a joint Statement of Intent. This was followed by definition of joint scientific projects, negotiations for drafting a Memorandum of Understanding, and formal government approvals on both sides. The signing of the present MOU marks the beginning of a new phase in Indo-US cooperation in earth and atmospheric sciences that is expected to expand into allied areas such as global change and environmental monitoring.

MOU on IRS-P3 Data

Another MOU was signed on November 21, 1997 by ISRO, NASA and the German Aerospace Centre (DLR) which allows NASA to receive data from the Modular Opto-Electronic Scanner (MOS) on board the Indian Remote Sensing Satellite, IRS-P3. MOS is an 18-channel spectrometer developed by DLR and, as part of the cooperation between



The picture shows how snow, ice and cloud can be discriminated using the Short-Wave Infra-Red (SWIR) band data of Modular Opto-electronic Scanner flown on IRS-P3.

ISRO and DLR, it was flown as one of the payloads on board IRS-P3 launched by India's PSLV on March 21, 1996; besides MOS, IRS-P3 carries a Wide Field Sensor and an X-ray astronomy payload. This tripartite MOU also envisages further cooperation among the scientists of the three countries in analysing the data for measurement and better understanding of the ocean and atmospheric parameters from space. ○

ISRO Takes Over Chairmanship of International Space Committee

ISRO has taken over the Chairmanship of the International Committee on Earth Observation Satellites (CEOS) from the French National Space Agency, CNES, at the 11th plenary meeting of CEOS which concluded at Tolouse, France, on November 21, 1997. CEOS is the apex body of various space agencies which coordinates space-based earth observation systems. This international position for ISRO is a recognition of its achievements, notably, in the field of remote sensing satellites and their applications. ISRO will host the secretariat of the CEOS and steer the CEOS activities till November 1998 when the 12th plenary will be held in Bangalore.

With several earth observation satellites, launched by different countries, providing various types of data, CEOS has an important role of coordinating these earth observation missions to ensure good data services to the users. It is expected that soon, there will be an evolution of an Integrated Global Observ-ing Strategy (IGOS) between space agencies and user agencies to promote effective utilisation of earth observation data for global applications. ISRO, as Chairman of CEOS, has to play the prime role in furthering these activities.

Already ISRO's remote sensing programme has attracted world-wide attention, especially, with the successful launching of IRS-1D satellite on September 29, 1997 which, together with IRS-1C satellite launched in December 1995, provides global data services. With 5.8 m resolution camera systems, these two satellites provide the best resolution imageries among the civilian remote sensing satellites in operation today. With plans to launch satellites for oceanography, large-scale mapping and resources survey, in the coming years, ISRO is expected to continue to actively contribute to the space-based remote sensing activities in the world. It is in this context that ISRO's taking over the Chairmanship of CEOS assumes significance.

CEOS has 20 space agencies as its members, 12 users agencies as affiliates and 4 observers. The yearly activities of CEOS are reviewed at its annual Plenary. CEOS func-tions through a secretariat and two working groups — one on information systems and services and the other on calibration and validation of sensors. ISRO, apart from hosting the secretariat, actively participates in the two work-ing groups; recently the meet-ing of the working group on information systems and services was hosted at Bangalore.

International Workshop on MST Radar Held in Bangalore

The inaugural session – seen sitting (left to right) are Dr P Balarama Rao, Director, NMRF, Prof R Narasimha, Member, Space Commission, Dr A P Mitra, Chairman, ISRO's Advisory Committee on Space Science and Dr J Roettger, Chairman of 'mst8' International Steering Group. Proposing the vote of thanks is Dr S C Chakravarthy, Convener, Local Organising Committee.

The 8th International Workshop on Mesosphere-Stratosphere-Troposphere Radar, mst8, was held in Bangalore during December 15-20, 1997. The workshop was attended by 130 delegates including 52 foreign delegates representing 17 countries. Various aspects of MST Radar observations, results and new developments of radar techniques were discussed during the workshop which was inaugurated by Prof R Narasimha, Member, Space Commission, and Director, National Institute of Advance Studies, Bangalore. Prof A P Mitra, Chairman, ISRO's Advisory Committee on Space Sciences presided over the inaugural function. Dr J Roettger was the Chairman of the International Steering Group of mst8.

Studies of the middle and lower atmosphere have substantially benefited with the advent of radar techniques. A particular promotion has been the introduction of the Mesosphere-Stratosphere-Troposphere (MST) Radar which are operating in several parts of the world for probing different regions of the atmosphere from 5 km to 100 km altitude to study the atmospheric dynamical processes that affect the weather and climate conditions. These radars usually operate in the low VHF band (around 50 MHz) and make use of scattering and partial reflection from variations in the atmospheric refractive index, which are caused by inhomogenities in humidity and temperature in the troposphere and stratosphere and electron density in the mesosphere. Included in this research are also radars that operate in MF and UHF bands. The VHF radar technique is also applied for ionospheric studies as well as for meteorological operations as wind profilers.

While most of the MST Radars are located at middle and high latitudes, the Indian MST Radar at Gadanki near Tirupati which became operational in the beginning of 1994, is located at low lattidude and therefore it is of vital significance for investigations of special features of the equatorial and low latitude atmospheric winds and waves. The Indian MST radar is also the third largest — the first two are in Jicamara, Peru, and Shigaraki, Japan — and it fills critical gaps of information for evolving accurate global climate models. It is also the only facility for probing weather pollution and climate related phenomena over the tropics. Selection of India for holding mst8 thus assumes great importance.

During the mst8, scientific presentations were organised in 15 technical sessions covering 4 major topics — scattering

processes, atmospheric dynamics, meteorology and new developments and facilities. In all, 162 papers, including 38 displayed as posters, were presented. A number of discussions also took place to identify possible international collaborative projects using the Indian MST Radar for joint investigations. In the final plenary session, presided by Dr J Roettger, the deliberations of the different sessions were summarised, several recommendations on scientific, operational and educational activities were adopted.

'mst8' proved to be very useful for in-depth discussions on new results from Indian and other MST Radars. The next workshop, mst9 will be held at Toulouse, France in March 2000.

Coinciding with the workshop, a school on atmospheric radar was also organised at Tirupati during December 10-13, 1997 with an objective to impart necessary training to young scientists from all over the world. International experts in the field lectured during the school.

National MST Radar Facility

National MST Radar Facility (NMRF) is an autonomous scientific institution under the Department of Space. It is located at Gadanki (13.5° N, 79.2° E), 32 km from Tirupati off the Chittoor-Tirupati main road in a picturesque landscape spreading over an area of about 30 acres. Establishment of NMRF was undertaken as a multi-agency project with Department of Space as the nodal agency, supported by Council of Scientific and Industrial Research, Department of Electronics, Department of Environment and Department of Science and Technology.

Fully commissioned in 1994, NMRF is being used by scientists from universities and research institutions for investigating winds and waves, wind shears and turbulence, structured layers, transport and diffusion of atmospheric constituents, momentum and eddy fluxes and ionospheric field-aligned irregularities. The University Grants Commission has set up a special centre at Sri Venkateswara University, Tirupati called 'UGC-SVU Centre for MST Radar Applications' to provide support to scientists and students from the Universities to make effective use of the facility.

NMRF has also entered into a collaboration with the Communications Research Laboratory (CRL) of Japan for setting up two complementary facilities, a Boundary Layer Radar and a Rayleigh Lidar to augment the integrated study of the tropical atmosphere, for the first time in the world.

The Yagi antenna array of NMRF at Gadanki

NMRF Specifications

Frequency	53 MHz
Antenna	1024 Crossed Yagi Elements
Beam Width	3°
Beam Directions	6-positions (Zenith, ±20° in EW & NS planes and ionospheric beam at 14.8°N)
Antenna Effective Area	12,500 sq.m.
Peak Power	2.5 MW
Duty Ratio	Up to 2.5%
Pulse Width	1 µs - 32 µs
PRF	62.5 Hz - 8 kHz
Maximum Range Resolution	150 m
Maximum Range Bins	256
Maximum FFT Points	512
Velocity Resolution	0.1 m/s
Time Resolution	80 s

ISRO's Sounding Rocket Launched from Norway

RH-300 in its final satages of readiness at Ny Alesund.

An ISRO-built Rohini Sounding Rocket, RH-300 Mk-II, was launched on November 20, 1997 from the Norwegian Space Centre's range at Ny Alesund (79° North Latitude) in the Svalbard group of Islands, close to the North Pole. The Norwegian Space Centre (NSC) had procured this rocket from ISRO through Antrix Corporation of the Department of Space for conducting scientific experiments in the 'D' region (60-120 km) and 'E' region (120-200 km) of the atmosphere. This sounding rocket had undergone extensive tests at ISRO to ensure its performance at very low temperatures that are prevalent in the polar regions.

A team of ISRO experts also participated in the preparation and launch of the rocket from Ny Alesund range which was inaugurated on November 15, 1997.

ISRO has a series of Sounding Rockets with varying payload capabilities and altitude range and these are used to conduct atmospheric research. RH-300 Mk-II is one of the presently operational sounding rockets of ISRO.

International Symposium on Earth Observation System for Sustainable Development

Briefing of ISRS activities by its President Dr D P Rao, during inaugural session of the symposium. Seated from left to right are: Dr Lawrence W Fritz, President, ISPRS, Dr K Kasturirangan, Chairman, ISRO, Dr George Joseph, President, ISPRS (TC-1) and Mr V Jayaraman, Director, Earth Observation Systems Programme, ISRO.

The International Society for Photogrammetry and Remote Sensing (ISPRS) Technical Commission - 1 and the Indian Society of Remote Sensing (ISRS) jointly organised an International Symposium on Earth Observation System for Sustainable Development during February 25-27, 1998 in Bangalore. The symposium was inaugurated by Dr K Kasturirangan, Chairman, Space Commission/Secretary, Department of Space. The inaugural session was presided by Dr Lawrence W Fritz, President, ISPRS. About 200 participants, including 80 foreign delegates, took part in the three-day symposium.

Imaging of the earth from space is becoming crucial in understanding various processes and its preservation. The rapid increase in greenhouse gases in the atmosphere, large scale deforestation and its impact on biodiversity, land degradation resulting in decrease of agricultural productivity, pollution, etc, have become local as well as global concerns. Rapidly growing population and limited resources are serious concerns facing the makind. In this context, sustainable development has become very important. Earth observation systems to facilitate sustainable development at both global level as well as at locale-specific level for its actual realisation, have an important role to play.

The International Society for Photogrammetry and Remote Sensing (ISPRS), established in 1910, is a non-governmental organisation engaged in promoting international

cooperation, coordination and advancement of photogrammetry, remote sensing, geographic information systems and related sciences to improve qualiy of life of mankind. all scientific and technical activities of ISPRS is being conducted through its seven technical commissions covering various aspects of sensors, data processing and analysis, theory and algorithms, Geographical Information System, environment, resources and education.

The ISPRS Technical Commission-1 (TC-1) on Sensors, Platforms and Imagery, which organised the symposium in Bangalore, is actively engaged in planning aerial space missions, inter-calibrtion of sensors, preprocessing, data quality and archival of remote sensing data. Considering the expertise it has in earth observation satellites and their applications, India has been elected as the President of ISPRS Technical Commission-1 (TC-1) for 1996-2000; Dr George Joseph, Director of ISRO's Space Applications Centre at Ahmedabad, is its President. The Indian Society of Remote Sensing (ISRS), which played an active role in organising the present symposium, was set up in 1969 in DehraDun to foster the development of remote sensing by bringing together scientists, professionals, decision makers, administrators, industry and academia for focussing the activities of remote sensing technology and its application in India. Dr D P Rao, Director of National Remote Sensing Agency, Hyderabad is the President of the Indian Society of Remote Sensing (ISRS).

The International Symposium on Earth Observation Systems for Sustainable Development was designed to exchange ideas and to interact with scientists, engineers, users in fields of photogrammetry and remote sensing, coming from universities, research institutions, government organisations, industries and engineering firms. Some of the topics covered include Sensors and Platforms to Topographic Surveys, Sensor Parameter Standardisation & Calibration, Microwave Remote Sensing, Preprocessing of Image Data, Image Data Archival and Dissemination, Advanced Platforms and Sensors, Application oriented Processing and Derivation of Height Information. Preceding the symposium, two parallel tutorials on Electro-optical Sensors for Remote Sensing and Image Pre-processing, was also held during February 23-24, 1998.

The holding of the above international symposium in India assumes significance since the country now leads in not only designing and launching advanced remote sensing satellites, but also in the application of this advanced technology for resources management. Data from Indian Remote Sensing satellites is being received by many countries including USA, Europe and Japan, under commercial agreements. India, at present, also holds the Chairmanship of the International Committee on Earth Observation Satellites (CEOS).

Strap-on Stage of GSLV Qualified

A major milestone was crossed on March 5, 1998 in the development of Geosynchronous Satellite Launch Vehicle (GSLV) with the successful qualification test of the liquid propulsion strap-on stage (L-40) at the Liquid Propulsion Test Facility at Mahendragiri near Nagercoil in Tamil Nadu. The L-40 stage, four of which are employed as strap-on boosters of GSLV, is 2.1 metre in diameter and 19.6 metre in length. It uses 40 tonne of liquid propellants– Unsymmetrical Di-methyl Hydrazine as fuel and Nitrogen Tetroxide as oxidiser. The stage develops a thrust of 60 tonne and burns for 160sec. The development tests had been successfully carried out earlier, in May 1997.

As part of the present qualification test of the stage, a short duration (20 sec) test of the stage was conducted on February 6, 1998 and, based on the analysis of the results of that test, the long duration firing for a duration of 160 sec was conducted on March, 1998. All the systems performed to specifications. The gimbal control actuation system employed for controlling the vehicle in all the three axes (pitch, roll and yaw) during the operation of this stage, has also been subjected to pre-programmed test cycles.

L-40, GSLV Strap-on Liquid Propellant Motor under test

GSLV, which is now under development by ISRO, is intended for launching INSAT class of satellites into geo-synchronous transfer orbit of about 175 km perigee and 36,000 km apogee. In the launch sequence, the four liquid propulsion strap-on stages are ignited on the ground along with the core solid propellant motor.

The Liquid Propulsion Systems Centre (LPSC), Thiruvananthapuram, is the lead Centre for the design, development and testing of the stage. Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram, is responsible for the development of engine gimbal control system.

L-40, the Liquid Propulsion Strap-on stage of GSLV which was successfully tested on March 5, 1998.

Young Talents Visit Space Centres

The students and their escorts pose for a group photograph with ISRO Chairman, Dr K Kasturirangan (sixth from right) at Antariksh Bhavan

To mark its Silver Jubilee year, the Department of Space invited young talented students from all over the country to see what has been achieved by India in the field of space. Fourteen students who had secured First Rank in 1997 X Standard Examinations conducted by their respective States (Andhra Pradesh, Assam, Andaman and Nicobar, Daman, Goa, Himachal Pradesh, Karnataka, Manipur, Meghalaya, Orissa, Pondicherry, Rajastan, Tamil Nadu and Uttar Pradesh), accompanied by one of their parents/guardians, flew to Chennai on December 25, 1997 to be the guests of ISRO/DOS for the next ten days.

The following morning, an air conditioned bus was ready to take them to the Liquid Propulsion Test Facilities (LPTF) at Mahendragiri. It was a day long journey but the students were quite enthusiastic, cheerful and enjoying the company of their new friends from other States. It was a hectic day for them on 27th because they had to go around LPTF and visit Vikram Sarabhai Space Centre, Thiruvananthapuram, 90 km away. The walking inside the campuses itself must have been tiresome but the students never allowed anything to stop their quest for knowing all about space; there seemed to be no end to the series of questions they put to the senior scientists. There was some relaxation from the knowledge building exercise when the students visited Kanyakumari.

The students were taken to Mysore on 29th and on 30th they visited ISRO Satellite Centre, Bangalore in the morning. It was a great joy for them when Dr K Kasturirangan, Chairman, ISRO spent about two hours with them at Antariksh Bhavan, the headquarters of ISRO, discussing on the space programme and the students told about the future career that they would like to pursue; each

The students holding discussions with Prof U R Rao, Member, Space Commission.

one of them was very clear on what he/she wanted to become. After meeting Prof U R Rao, Member, Space Commission in the afternoon, the students visited the Raman Research Institute and ISRO Telemetry, Tracking and Command Network Station where they were shown how the satellites are tracked and controlled.

On December 31, the students left for Hyderabad and on the way they visited the IRS satellite Data Reception Centre to see for themselves how the Indian Remote Sensing Satellites was watching our country from above. They celebrated their new year's day at National Remote Sensing Agency even as they saw the various data products of IRS besides learning from scientists there on how the data helps in monitoring and managing natural resources. The next day they travelled to ISRO's launch centre at Sriharikota. They were taken around the Centre on January 3, 1998 and shown video of PSLV launch. The following day, the students flew back to their respective places.

The tour was no doubt hectic but it was a unique opportunity for these young and enthusiastic talented students not only to look at the various facilities and laboratories but also to interact and seek clarifications from senior scientists. The tour was also unique in the sense that it brought the First Rank Students from different States/Union Territories together.

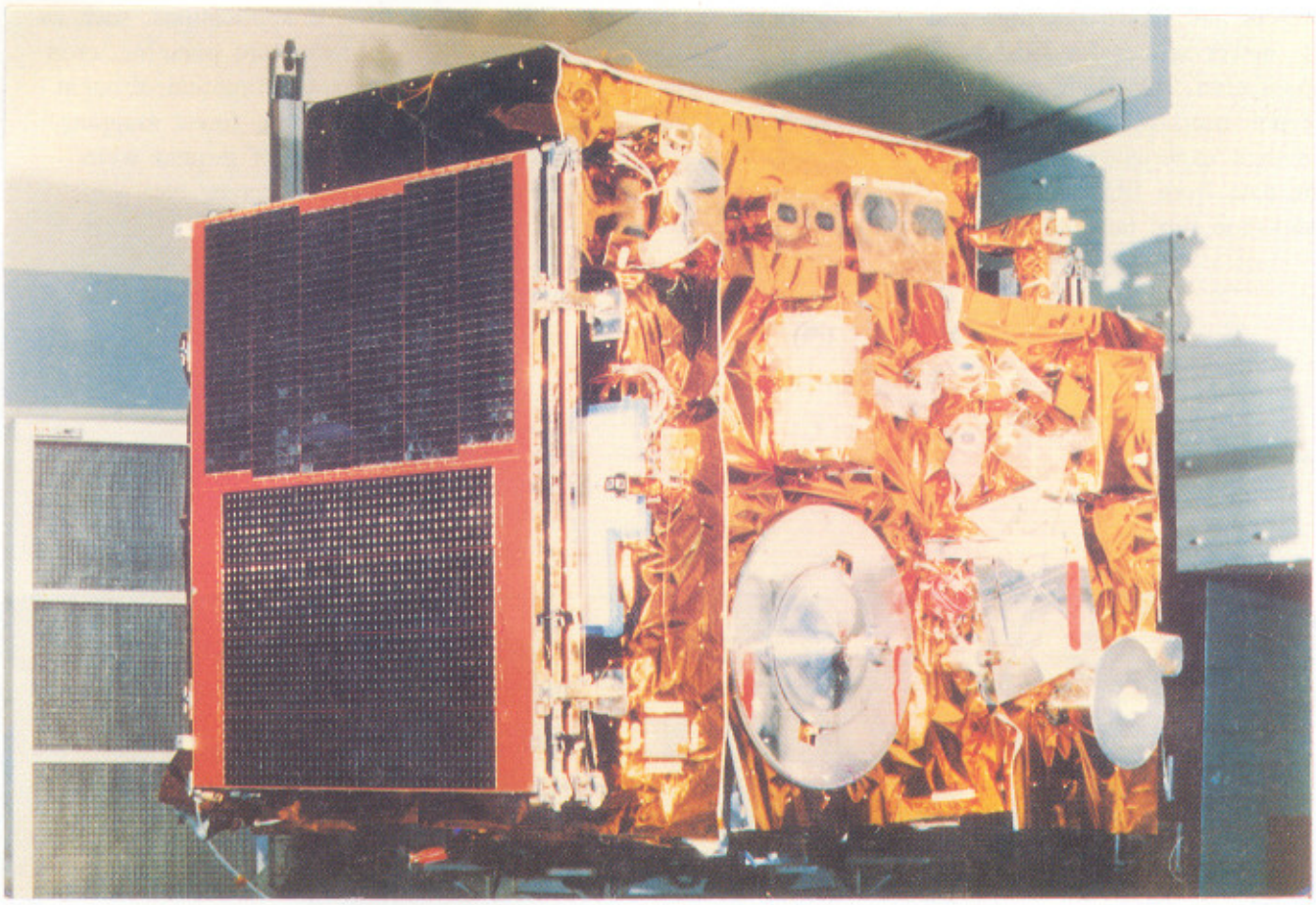
UN Space Centre Concludes Agreement With India

The Host Country Agreement between the UN-affiliated Centre for Space Science and Technology Education in Asia and the Pacific (CSSTE-AP) and the Government of India was concluded on March 10, 1998 at the third Governing Board meeting of CSSTE-AP at Ahmedabad. The Agreement was signed by Prof B L Deekshatulu, Director, on behalf of CSSTE-AP and Dr K Kasturirangan, Chairman, ISRO/Secretary, Department of Space on behalf of the Government of India. Members of 12 countries and the United Nations, who constitute the Governing Board, re-elected Dr Kasturirangan, Chairman, ISRO/Secretary, DOS as Chairman of the Board for another term of two years. Dr Kasturirangan had been elected the first Chairman of the Board when CSSTE-AP was established in November 1995. The Board also approved the education programme of CSSTE-AP for the coming years.

The CSSTE-AP was established in India in November 1995 around the facilities of the Indian Institute of Remote Sensing (IIRS), Dehradun and the Space Applications Centre (SAC), Ahmedabad of the Department of Space. The Indian Centre is the first of the regional Centres to be set up at the initiative of the United Nations. It is an educational institution that enables the Member States to build indigenous capabilities in the utilisation of Space Science and Technology and offers opportunities to them to partake in the benefits of this high technology area. The Centre offers Post-Graduate education courses, leading to award of M Tech/M Sc (Tech) degrees, in Remote Sensing and Geographical Information Systems, Satellite Communications, Satellite Meteorology and Space Sciences to students of different countries in the region. Since its establishment, CSSTE-AP has already concluded two courses of 9 months duration - one each on Remote Sensing and GIS, and Satellite Communications. The second 9-month course on Remote Sensing and GIS is presently in progress. In all, 80 students from 20 countries have benefited from the CSSTE educational courses.

As part of the CSSTE-AP programme, a nine-month Post Graduate course on Satellite Meteorology and a one-week Professor Verner Suomi Memorial International Workshop on Emerging Trends in Satellite Meteorology - Technology and Applications, were inaugurated on March 9, 1998 at SAC, Ahmedabad. The Satellite Meteorology course has 18 participants from 10 countries. The one-week workshop had 100 participants including those from foreign countries.

Ten Years of Indian Remote Sensing Satellites



It was on March 17, 1988 that the first operational remote sensing satellite, IRS-1A, was launched by India heralding the operational era of space-based remote sensing using indigenously designed and built satellites. The decade that has gone by has seen regular dissemination of data products from IRS-1A and the follow-on satellites, IRS-1B, IRS-P2, IRS-1C, IRS-P3 and IRS-1D launched at regular intervals. Improvements in sensor capabilities and revisits have propelled IRS data as the first choice amongst the users in the country. Inroads have also been made in the international markets and IRS data is gaining global acceptance as several ground stations have started to acquire IRS data. About 10 percent of the revenue of National Remote Sensing Agency (NRSA) is from data sales to foreign users. IRS-1C/1D data have benefitted applications such as urban mapping/planning, vegetation monitoring and integrated land and water resources mapping at micro level.

Coinciding with the completion of a decade of Indian remote sensing satellites, a User Interaction Workshop was organised by NRSA at Hyderabad, during March 17-18, 1998. The workshop was inaugurated by Dr K Kasturirangan, Chairman, ISRO. Shri Vinay Shankar, former Secretary, Department of Rural Developments, released the IRS-1D Users' Handbook. An exhibition of satellite data products was also organised on this occasion which was inaugurated by Prof B L Deekshatulu, Director, Centre for Space Science and

Technology Education in the Asia Pacific Region. More than 300 users across the country participated in the workshop, during which senior scientists from ISRO presented the salient features of the present and future satellites and the newer scopes for IRS data application. On their part, several users made presentation on their experience of utilising the data from IRS. The workshop thus helped in keeping the users informed about the developments in the area of new sensors, data products and services, while the satellite system designers got a feed back from the users on the requirements for data specifications, product medium, format and associated services.

National Remote Sensing Agency is the nodal agency in the country for the distribution of IRS satellite data products in India. There are more than 600 active users in the country belonging to almost all sectors of the economy who are procuring upwards of 16,000 images worth about 110 million rupees every year for diverse applications, such as infrastructure planning, crop acreage estimation, drought monitoring, forest mapping, mapping of ground water potential zones, etc.

Courses Planned at CSSTE-AP

Apart from the already conducted courses, the future plan of the Centre is to conduct education programmes as per the following schedule:

* Remote Sensing (RS) and Geographical Information System (GIS course)	1 year and 9 months	- October 1, 1998 onwards
* Satellite Communication course	1 year and 9 months	- early, 1999 onwards
* Space Science course	1 year	- June 1, 1998 onwards
* Remote Sensing & GIS course	1 year and 9 months	

Subsequent to these courses, another cycle of courses would start and almost 4 courses per year (in the 4 disciplines) is planned to be conducted after 1999.

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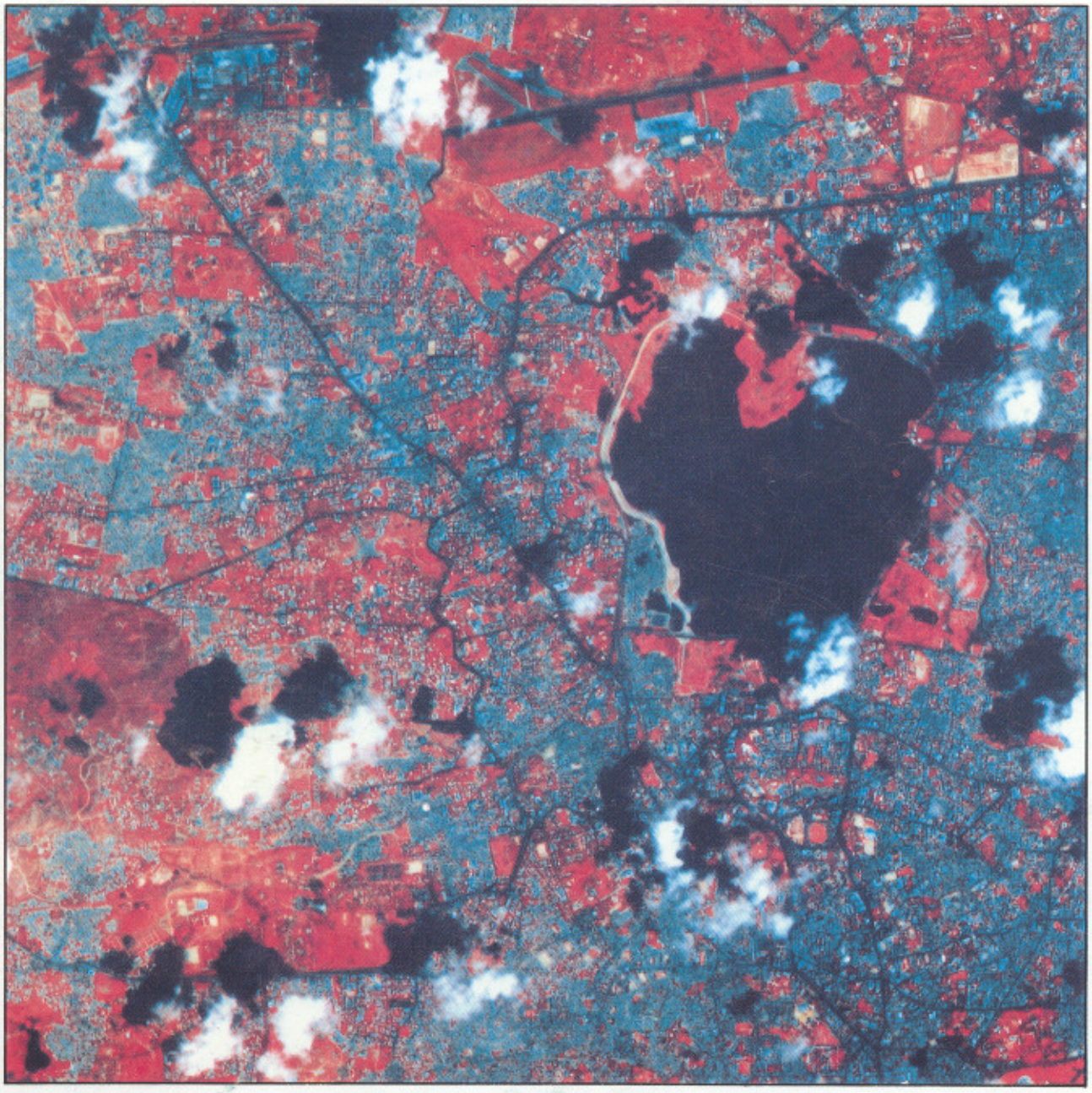
INSAT System Capability Augmented

The INSAT system capability has been augmented by acquiring an in-orbit satellite, Arabsat-1C, from ARABSAT which is an inter-governmental satellite consortium of Arab States headquartered in Riyadh, Saudi Arabia. The satellite, has now been designated INSAT-2DT. It was moved to an INSAT orbital position at 55 degree East Longitude and all tests were completed by January 15, 1998. INSAT Master Control Facility (INSAT-MCF) at Hassan in Karnataka has taken control of the satellite.

The Department of Space entered into the agreement with ARABSAT for the acquisition of ARABSAT-1C in November 1997 at a cost of US $ 40 million, which includes the satellite in orbit, insurance coverage for one year and all the control equipment and software. The satellite carries 25 C-band transponders and one S-band transponder and has sufficient fuel on board for its operation for about five years from now. The transponders are being loaded in a phased manner.

INSAT-2DT will partly augment the INSAT system capacity that was depleted by the loss of INSAT-2D following a power bus anomaly in October 1997.



Imagery of Hyderabad City taken by IRS-1D on October 12, 1997.