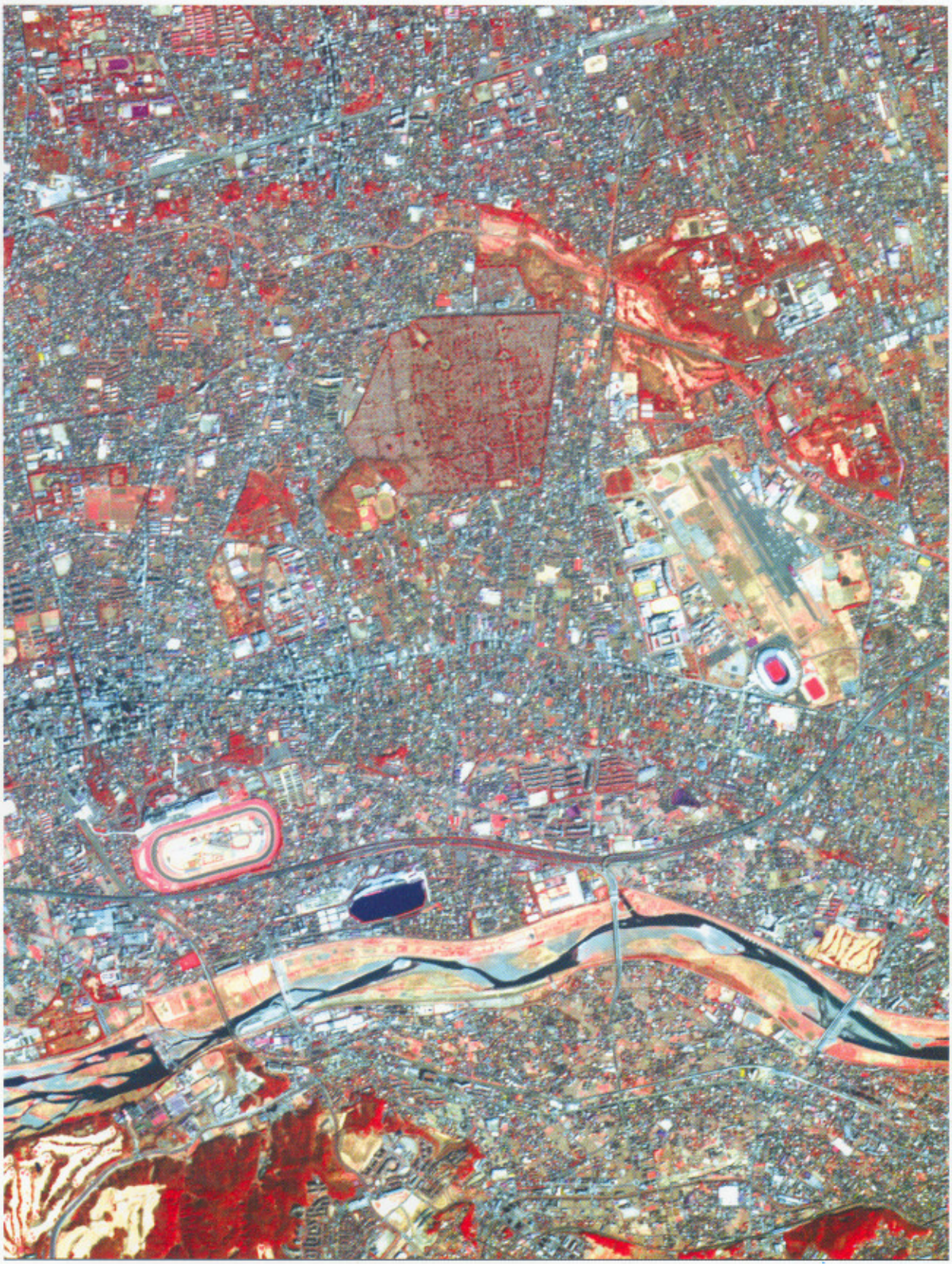
January-March 2004

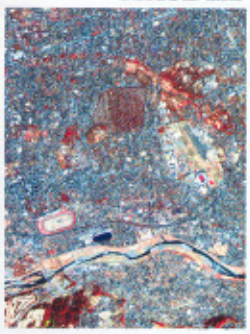
SPACE india



INDIAN SPACE RESEARCH ORGANISATION

Routes covered under the Land Aerosol Campaign (Article on Page 2)

- National Physical Laboratory & Central Road Research Institute
- Physical Research Laboratory
- Indian Institute of Tropical Meteorology
- National Remote Sensing Agency
- Andhra University
- Indian Institute of Science & Ananthapur University
- ISRO's Space Physics Laboratory



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Cover Page: *Part of Chicago, USA as seen by RESOURCESAT-1 LISS-4 Camera*

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Aerosol Campaign for Geosphere Biosphere Programme

ISRO, along with several national scientific institutions, organised a special land based campaign on atmospheric aerosols during February 1-29, 2004 as an important part of the Geosphere Biosphere Programme (GBP).

During this special campaign, vehicles equipped with sophisticated instruments travelled about 8,000 km in south India to measure physical, chemical and optical properties of aerosols and trace gases along the road corridors. February was specifically chosen for the campaign, since, during this month, any reduction of aerosols due to precipitation is not expected and hence the average conditions of aerosols in the ambient environment would be provided.

Aerosols are small particles suspended in solid or liquid form dispersed in a gaseous medium. In the case of atmospheric aerosols, the dispersion medium is the atmosphere and the term aerosol is frequently used to represent their dispersed state.

Quartz Crystal Microbalance used for aerosol and mass concentration study

Atmospheric aerosols assume greater importance due to their influence on human health and their potential to perturb the earth's climate both by directly altering the radiation reaching the earth's surface and indirectly altering the properties of the clouds, etc.

The presence of atmospheric aerosols, as they scatter or absorb solar radiation, could lead to the formation of haze, mist, fog, etc., which in turn, can result in visibility reduction and alter the way earth's atmosphere radiates heat. The aerosols mostly reside in the troposphere (lowest layer of the atmosphere) and act as centres for photochemical reactions forming complex heterogeneous chemicals in the troposphere. Their size varies from 10^{-3} micrometre (one billionth of a metre) to as much as 10^{2} micrometre (one ten thousandth of a metre). This wide spectrum makes them very complex species as most of their effect strongly depends on their size.

Atmospheric aerosols assume greater importance due to their influence on human health and their potential to perturb the earth's climate both by directly altering the radiation reaching the earth's surface and indirectly altering the properties of the clouds, etc.

Atmospheric aerosols can be broadly classified into marine, continental and background aerosols. Based on particle radius, they can be classified into Aitken (0.001 – 0.01 micrometre), large (0.1 – 1 micrometre) and giant particles (>1 micrometre). The size of aerosols is an important parameter in determining their optical properties and their movement. The size of aerosols also to some extent influences the photochemical processes that form complex chemical compounds in the atmosphere.

The aerosols can be characterized by virtue of their physical, optical and chemical properties. Sporadic events like volcanic eruptions throw up huge amounts of dust and toxic gases into the atmosphere which finally settle with a longer residence time in the stratosphere. The multiplicity of sources of aerosols range from atmospheric dust, sand storms, soil erosion, biomass burning, thermal power plants, coal mines, industrial effluents, vehicular pollution, etc.

Though aerosols can be homogeneous, at far off locations, aerosols mix with various other ambient trace gases and trace elements to become

heterogeneous/complex in nature. In addition to various trace gases, there would be several other elements that constitute the composition of aerosols. The combined effect of these trace gases and other elements and the photochemical reactions which they undergo, determine the optical properties of aerosols.

Broadly, the atmospheric aerosols constitute various elements of dust particles, trace gases, etc. These, in the dispersed medium of atmosphere in presence of water vapour and solar radiation, horizontally move at far off levels from the source regions and mix well while undergoing photochemical reactions to form complex composition of aerosols. The complex heterogeneous chemistry of aerosols is thus largely different from the source regions and exhibits altogether a different composition in the non-source regions or the well-mixed regions.

Normally, the residence time of atmospheric aerosols during the calm weather conditions do not exceed more than a week. However, depending on the size and nature of composition, the aerosols might get transported to longer distances with increase in altitude and become photochemically reactive. Thus, their mean residence time could exceed a few weeks. This is evident in the case of Ozone formation in the presence of precursors of Carbon Monoxide and Nitrogen Oxide pollutants generated as a result of industrialisation and vehicular pollution.

In view of the varied bio-climatic conditions, the characterisation of the average distribution of aerosols and trace gases over the Indian land mass is the main objective of land-based campaign.

The diversified developmental activities and the rapid changes occurring in land use and land cover are resulting in elevated flux of atmospheric pollutants, aerosols and trace gases in the ambient air. The diverse nature of the Indian landmass ranging from high mountainous areas, urban, rural, and coastal to desert regions exhibit varied source strengths for aerosol emissions.

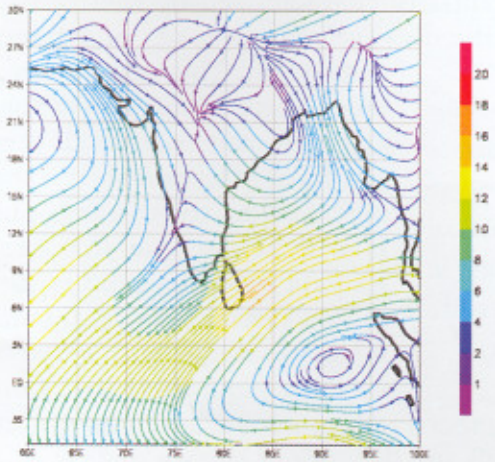
In view of the varied bio-climatic conditions, the characterisation of the average distribution of aerosols and trace gases over the Indian land mass is the main objective of land-based campaign.

The regional and geographical distribution of atmospheric aerosols and the trace gases across the country is little understood to characterize the atmospheric trace constituents and their influence on the atmosphere.

Against this background, the Land Based Aerosol Campaign undertaken in February 2004 is an important step in characterising the atmospheric aerosols and trace gases.

The institutions that took part in the campaign are: National Remote Sensing Agency (NRSA), Hyderabad; Physical Research Laboratory (PRL), Ahmedabad; ISRO's Space Physics Laboratory (SPL) at Thiruvananthapuram; Central Road Research Institute (CRRI) New Delhi; National Physical Laboratory (NPL), New Delhi; Indian Institute of Tropical Meteorology (IITM), Pune; Indian Institute of Science (IISc.), Bangalore; Andhra University, Vishakapatnam; and Sri Krishnadevaraya University, Ananthapur.

The instruments for the campaign included Multi-wavelength Micro-tops and Multi-wavelength radiometers to measure aerosol optical depths, Ozone and trace gas analysers, and meteorological



Wind pattern over India and its surroundings in February 2004 showing continental source of aerosols

High volume air samplers & other meteorological instruments at Shadnagar

kits. The measurements were made daily during 9-11 am and 2-4 pm. Nearly 60 scientists accompanied by 15 instrumented vehicles participated in the land based campaign of aerosols.

It was a unique sight when all the vehicles that started from seven different regions, converged at Shadnagar on February 14 where NRSA's Data Reception station for Indian remote sensing satellites is located. Shadnagar, located at a distance of 70 km from Hyderabad, free from industrialisation and human disturbances, provided the right ambience for making observations by all the vehicle mounted instruments and to calibrate them. A week long inter comparison of various instruments resulted in highlighting the performance characteristics of various instruments and their relative biases.

The Special Land Based Campaign on Aerosols would provide better insight into the properties of the composition of aerosols and their distribution across various latitudes. The understanding of the aerosol characteristics and chemistry helps quantifying the atmospheric radiative forcing in a better way.

Micropulse Lidar mounted in a mobile van

The surface measurements of aerosols and trace gases, "Land Campaign on Aerosols" was complemented by balloon-borne radiosonde and Ozonesonde measurements made up to an altitude of 33 km over Hyderabad. It provided temperature, humidity and Ozone profiles to understand the horizontal and vertical movements. An aerial surveillance was also performed to sample

NRSA aircraft used for aerosol sampling

the ambient Carbon Monoxide, Nitrogen Oxides, and Black Carbon in a 100 km north-south corridor over Hyderabad at 4 altitude levels covering 300 meters, 800 meters, 1200 meters and 2000 meters. A Mobile Pulse Lidar (MPL) was also flown both during day and night using an NRSA aircraft covering 6 and 8 km altitudes. The MPL helps in studying the physical properties of atmospheric aerosols in a continuous pulse mode by the green laser of 568 nanometer wavelength.

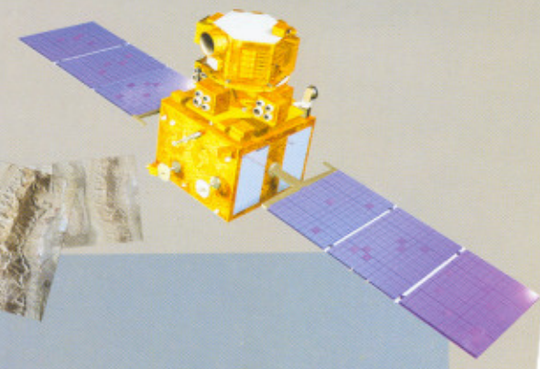
The deployment of instuments for sampling airborne aerosols and trace gas measurements, as well as these observations over the Indian continent heralds a new chapter in aerosol research and climate observations initiated by ISRO.

The land based aerosol campaign of ISRO-GBP has been carried out for the first time on such a magnitude in a collaborative manner to characterise the atmospheric aerosols and trace gases. It is also planned to cover the north, northwestern and northeastern parts of India later. With these campaigns, it is possible to provide aerosol optical depth map of India substantially characterised by their chemical constituents, optical properties and trace gas distribution. This study would also provide better insights on the natural and man made sources of aerosols and trace gases and their transport mechanism to distant places. It will be used in the Aerosol Radiation Budget Studies as well as to understand chemical transport mechanism. It will serve as a valuable input to further enhance our understanding of the different aspects of aerosals and their role in climate studies.

The deployment of instuments for sampling airborne aerosols and trace gas measurements, as well as these observations over the Indian continent heralds a new chapter in aerosol research and climate observations initiated by ISRO.

(This article was contributed by Prof Shyam Lal of PRL, Dr C B S Dutt and Dr V Jayaraman of ISRO GBP Programme Office)

Space Imaging to Market RESOURCESAT-1 Data



Antrix Corporation of the Department of Space (DOS) and Space Imaging, USA, have signed an agreement to extend the sales and marketing arrangement for the Indian Remote Sensing satellite data between the two agencies. Mr K R Sridhara Murthi, Executive Director, ANTRIX and Mr Robert Dalal, CEO of Space Imaging, signed the agreement on January 27, 2004 in Bangalore, at a brief ceremony attended by Mr G Madhavan Nair, Chairman of ISRO and of Antrix Board. This agreement gives Space Imaging rights to market worldwide the data from ISRO's latest remote sensing satellite, RESOURCESAT-1, launched in October 2003 as well as CARTOSAT-1, planned for launch this year.

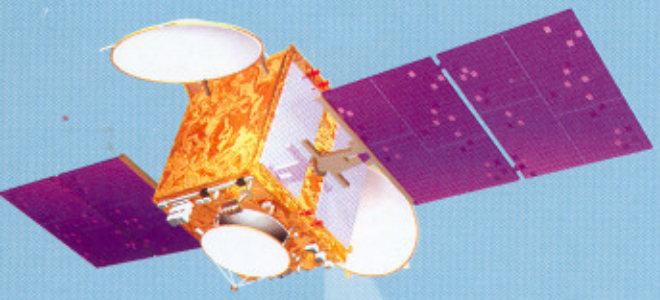
Speaking on the occasion, Chairman of ISRO, Mr Madhavan Nair said "ISRO, Antrix and Space Imaging have worked as partners to fulfill India's vision of a global commercial earth observation programme and I am happy that the Indian Remote Sensing satellite system has emerged as one of the most high-profile programmes in the imaging industry."

Mr Robert Dalal, CEO of Space Imaging, said that in the past eight years, 19 ground stations have been installed to access data from Indian Remote Sensing satellites, IRS-1C and IRS-1D, and hence the success of these satellites is without question. "The continuation of our long-standing marketing relationship with Antrix is an important step in our business plan. Combined with its successful launch and Space Imaging's worldwide user base, we are certain to gain maximum exposure of RESOURCESAT-1 imagery across many global markets" he added.

The Indian Remote Sensing Satellite (IRS) programme primarily began with the objective of meeting diverse needs of natural resource management and environment related needs in India and also for supporting advanced research in earth sciences. It started with IRS-1A and 1B, subsequently replaced with IRS-1C and 1D satellite systems, which provided to the user community the best set of resolutions and spectral characteristics in the civilian sector when they were launched into space. Besides, a satellite specialising in ocean applications was also put into service in 1999.

Over the years, IRS programme has taken deep roots and has become the mainstay for providing timely, repetitive, and synoptic information through space based systems for nationwide applications. The programme has generated over 500 committed users and more than 100 value adding business enterprises in India.

RESOURCESAT-1, the most advanced remote sensing satellite built by ISRO so far, was launched in October 2003 by India's Polar Satellite Launch Vehicle (PSLV). CARTOSAT-1 is scheduled for launch this year, by the same launcher.



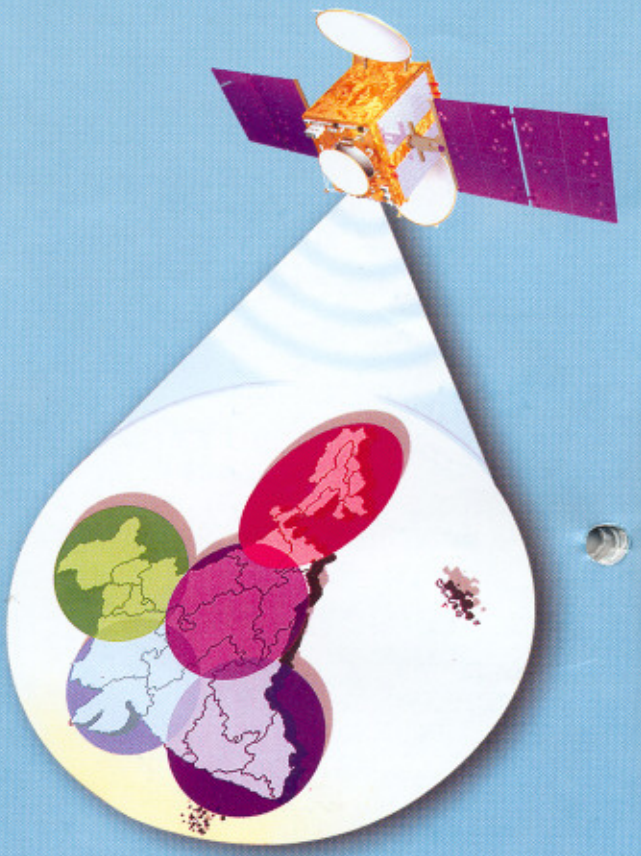
EDUSAT Pilot Project in Karnataka Inaugurated

The EDUSAT Pilot Project in Karnataka was inaugurated by Chief Minister of Karnataka, Mr S M Krishna, on January 28, 2004, at a function organised at the ISRO Satellite Centre, Bangalore. This pilot project forms part of the first phase of the EDUSAT programme.

With the objective of establishing a satellite-based distance education service in the country, the Indian Space Research Organisation (ISRO) will be launching EDUSAT, an exclusive satellite for educational services. EDUSAT will be launched by India's Geosynchronous Satellite Launch Vehicle, GSLV, in 2004. This satellite will be mainly utilised to demonstrate the concept of multicasting interactive multimedia for the educational sector and will, thus, act as a precursor to the future operational EDUSAT system.

EDUSAT is specially configured to have multiple beams covering different regions of India. The satellite will have a Ku-band transponder with its footprint covering the Indian mainland region. Another five Ku-band transponders will provide spot beams directed towards northern, north-eastern, eastern, southern and western regions of India.

In addition, EDUSAT will also carry six C-band transponders with their footprints covering the entire country.



Five spot beams of EDUSAT

EDUSAT system will be primarily meant for school, college and higher levels of education and will also support non formal education. The scope of EDUSAT programme will be realised in three phases. The Karnataka EDUSAT pilot project is covered under the first phase covering the pre-EDUSAT period. During this period, a Ku-band transponder on board ISRO's INSAT-3A or INSAT-3B, which are already in orbit, will be used.

In Karnataka, Visveswaraiah Technological University will be the main beneficiary of the pilot project with hundred nodes in the network covering all its engineering colleges. In addition, it is expected that other institutions of the Karnataka State Education Department will benefit from the project. Besides Karnataka,

Maharashtra and Madhya Pradesh will also implement similar pilot projects. In Maharashtra, the Y B Chavan State Open University, Nasik, will be covered under the pilot project while in Madhya Pradesh, the Rajiv Gandhi Technical University will be the beneficiary. Each location will cater to about 100 classrooms.

In the second phase, EDUSAT will be used in a semi-operational project with one uplink in each beam and about 100 to 200 classrooms per beam. In addition to the locations in Karnataka, Maharashtra, and Madhya Pradesh, two more states and one national institution will be covered in this phase. It is anticipated that more users will come forward to fund the ground reception network in this phase and build it up to about 1,000 classrooms per beam.

In the third phase, the EDUSAT network is expected to become fully operational. Manufacturers and service providers are expected to replicate the systems with funding by the end-users with technical and managerial support from the ISRO. Ground infrastructure to meet the educational needs of the country will be built up in the operational phase. EDUSAT will be able to support a total of 25 to 30 uplinks and about 5000 remote terminals per uplink. To meet the full requirements of the country, it may be necessary to add a constellation of satellites in a phased manner.

EDUSAT is another example of India's commitment to use space technology for national development.

Potential Applications

ISRO's Telemedicine Network Expands Further

ISRO's telemedicine network has got further fillip with the the launch of the operational phase of Karnataka Telemedicine Project and the inauguration of Telemedicine projects in West Bengal and the North East.

ISRO took up the initiative of telemedicine in the year 2001 to further expand the application of INSAT to newer areas with the specific aim of bringing in the expert medical facilities to the grassroots level population. Telemedicine helps to connect remote rural hospitals/health centres to super specialty hospitals located in the cities and helps patients in remote and rural areas to avail timely consultations from specialist doctors without the ordeal of travelling.

Telemedicine system consists of customised medical software integrated with computer hardware, along with medical diagnostic instruments connected to VSAT (Very Small Aperture Terminal) at each location. In the past three years, ISRO's telemedicine network has expanded to connect 45 remote and rural hospitals and 15 super specialty hospitals. The remote/rural nodes include the offshore islands of Andaman & Nicobar and Lakshadweep, the mountainous and hilly regions of Jammu and Kashmir including Kargil & Leh, Medical College hospitals in Orissa and some of the rural/district hospitals in the mainland states. More than 12,500 patients have been provided with specialty tele-consultation and treatment so far.

(Left to Right) Mr G Madhavan Nair, Chairman, ISRO, Mr S M Krishna, Chief Minister of Karnataka, Mr Satyabrata Mookherjee, Minister of State (Space) and Mr Kagodu Thimmappa, Minister for Health & Family Welfare, Government of Karnataka at the inauguration

In West Bengal, the Telemedicine Project which had started with connectivity between the district hospitals at Bankura and Siliguri with Asia Heart Foundation, Kolkata and Narayana Hrudayalaya, Bangalore, got further fillip with the inauguration of the connectivity between more hospitals by the Minister of State (Space), Mr Satyabrata Mookherjee on January 30, 2004 at Krishna Nagar. The District Hospital at Krishna Nagar in Nadia District, District Hospital, Malda and District Hospital, Balurghat in West Dinajpur district have now been connected with super specialty hospitals — Sri Ramakrishna Seva Prathistan Hospital, Kolkata and SSKM Hospital, Kolkata.

Interactive Meet on Telemedicine

As a part of the inauguration of telemedicine facility at Imphal, a user interaction meet on telemedicine was also organised. The meet was attended by 365 delegates including doctors from district and private hospitals, personnel of the science and technology departments, state remote sensing centres and commissioners and directors of health of some of the North Eastern States. During the meet, presentations were made on concepts of telemedicine systems, ISRO's initiatives and experience, ISRO's plan for telemedicine in North Eastern region, and activities of North Eastern Space Applications Centre. The presence of doctors from super specialty hospitals and a panel discussion at the end of the meet were other significant highlights.

The telemedicine project for the North Eastern Region of India was inaugurated on February 5 at Imphal by the Governor of Manipur, Mr Arvind Dave. The North Eastern telemedicine project envisages establishing telemedicine facility at 72 district hospitals in the eight states of the region and linking them with super specialty hospitals like Asia Heart Foundation, Kolkata; Apollo Hospitals; All India Institute of Medical Sciences, Delhi; Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow; and Amritha Institute of Medical Sciences, Kochi.

Telemedicine facility has already been established in some of the remote district hospitals of North Eastern States of Assam, Tripura, Manipur, and Sikkim. The project is a joint venture between ISRO and the North Eastern Council under the Department of Development of North Eastern Region.

In yet another function organised at the ISRO Telemetry, Tracking and Command Network (ISTRAC) in Bangalore on February 10, the operational phase of the Karnataka Telemedicine project was inaugurated by the Karnataka Chief Minister Mr S M Krishna. Mr Satyabrata Mookherjee, Union Minister of State (Space) graced the occasion. In the past two years, the pilot project on Telemedicine in Karnataka has already provided more than 10,000 teleconsultations. In the operational phase, the Karnataka Telemedicine Project is expected to bring multi-specialty healthcare to a significant section of the rural population of Karnataka. This network would serve as a model for the utilisation of 'HEALTHSAT' which is proposed for launch in the future.

International Conference on Global Spatial Data Infrastructure Held in Bangalore

The seventh International Conference of the Global Spatial Data Infrastructure, GSDI-7, was held at Bangalore during February 2-6, 2004. GSDI-7 with the theme "Spatial Data Infrastructure (SDI) for a sustainable future" was hosted jointly by Indian Space Research Organisation (ISRO) and the Department of Science and Technology (DST). The Conference was inaugurated by Dr K Kasturirangan, Member of Parliament (Rajya Sabha) on February 2, 2004. GSDI Conferences provide a forum to discuss a wide range of technical, scientific and policy-related issues associated with the use of Geographic Information technologies and the development of associated products and services. The earlier six conferences were held in Germany (1996), USA (1997), Australia (1998), South Africa (2000), Colombia (2001) and Hungary (2002).

Spatial information is vital to take sound decisions at the local, regional, state and central level planning, implementation of action plans, infrastructure development, disaster management support, and business development. Natural Resources management, flood mitigation, environmental restoration, land use assessments and disaster recovery are a few examples where decision-makers effectively use spatial information.

Satellite-based remote sensing data and the organisation of spatial databases around a Geographical Information System (GIS), combined with the Global Positioning System (GPS), have greatly benefited the spatial information systems. Using GIS technology, users are now able to process maps to provide a new perception.

GSDI-7 had four Plenaries and five Technical sessions that focused on spatial data infrastructure for a sustainable future. The conference deliberated on the policies, technologies, and applications for

Dr K Kasturirangan, Member of Parliament (Rajya Sabha) releases abstracts of GSDI-7 during inauguration

Delegates at a plenary session

making remote sensing and GIS essential parts of governance and commerce. It also addressed the national, regional, and global Spatial Data Infrastructure (SDI) initiatives.

The 7th GSDI brought to focus India's achievements in the field of imaging, mapping, and GIS applications, specifically, the competence in designing and building sophisticated satellites and launch vehicles for end-to-end services in communications, broadcasting, meteorology, resources management, and disaster management. In the limelight was the Indian Remote Sensing (IRS) Satellite system that has become the workhorse to provide effective spatial information support to decision making at local levels, natural resources management, environmental monitoring, and disaster management.

Spatial information is vital to take sound decisions at the local, regional, state and central level planning, implementation of action plans, infrastructure development, disaster management support and business development. Natural Resources management, flood mitigation, environmental restoration, land use assessments and disaster recovery are a few examples where decision-makers effectively use spatial information.

The GSDI-7 Conference brought together about 400 delegates from 36 countries including the ones from Argentina, Australia, Austria, Brazil, Canada, Chile, Colombia, France, Hungary, Kenya, Mexico, Namibia, Nepal, Poland, Russia, South Africa, Spain, Sri Lanka, Thailand, The Netherlands, UK, USA. Delegates from various Government Departments, academia, NGOs, and private enterprises in India also attended the conference.

Both ISRO and DST are championing the establishment of India's National Spatial Data Infrastructure (NSDI). A Strategy and Action Plan for India's NSDI have already been prepared and steps are underway to establish NSDI as a multi-agency programme. Because of its technological and programmatic capabilities, India is likely to play a leading role in the global scenario of Spatial Data Infrastructure.

A round table was held on February 7, 2004 between the Open GIS Consortium (OGC) and ANTRIX of the Department of Space, in which about 20 representatives from the Indian industries participated to discuss the interoperability and common standards for SDI. Another important outcome of the conference was that the GSDI Association has accepted India's offer to host the International Secretariat of GSDI Association at Bangalore.

An international exposition to Spatial World, organised as part of the conference, showcased the latest products and applications of GIS, GPS and Remote Sensing. Industries, business sector, government agencies, and academia from all over the world participated in the event. The Expo, which was also open to students, gave an opportunity to closely see the major scientific and technological achievements in SDI.

The Expo organised as part of GSDI-7

National Space Science Symposium Held at Kottayam

The 13th National Space Science Symposium (NSSS-2004) was held at Kottayam, Kerala during February 17-20, 2004. The Symposium was organised jointly by ISRO and Astronomical Society of India. NSSS-2004 was hosted by the School of Environmental Sciences, Mahatma Gandhi University, Kottayam.

Inaugurating the NSSS-2004, Mr G Madhavan Nair, Chairman, ISRO said that India's first scientific mission to moon, 'Chadrayaan-1', the astronomy satellite, 'Astrosat' and the Indo-French satellite, 'Megha-Tropiques' for studying tropical meteorology, show ISRO's commitment to space science. He stressed the need to develop indigenous models for climate studies and the interaction between space and earth systems. Welcoming the delegates, Dr Cyriac Thomas, Vice-Chancellor, Mahatma Gandhi University and Chairman, Local Organising Committee said that Kottayam would provide a congenial place for fruitful deliberations to strengthen space science research.

The NSSS, held biennially since the first one hosted by Banaras Hindu University in 1980, has become a premier scientific forum to discuss and guide the space science research in India. The NSSS-2004 at Kottayam had the participation of 343 delegates from 81 cities representing 23 institutions and 18 universities.

A view of Space Exhibition

Prof N Bhandari of PRL addressing the delegates on Indian Moon Mission

The topics for special plenary sessions at NSSS-2004 included *New Challenges of Lunar Exploration, Frontiers in Astronomy, Ultra High Energy Cosmic Rays, Dark matter in the Universe, Middle atmospheric dynamics using MST Radar and co-located facilities* and *GPS: Science and Applications.* Interdisciplinary lectures on 'Present Revolutions in Astronomy' and 'Microgravity Science and Space Capsule Recovery Experiment' were also organised besides popular lectures like 'Unveiling the Mystery of Moon: Indian Moon Mission' and 'Invading Mars'. A Panel Discussion with the participation of young scientists was also held.

Out of a total of 428 papers presented during the NSSS, 312 were included in the posters sessions.

Along with the NSSS-2004, a Space Science Exhibition was also arranged in association with the Baselius College, Kottayam. ISRO, National Remote Sensing Agency, BSNL, Rubber Board, several colleges and other organisations participated in the exhibition. Students of various colleges and schools besides general public in and around Kottayam visited the exhibition. Other highlights of NSSS-2004 were the Space Science Quiz and Space Parliament organised for students.

Vigyan Rail

ISRO is participating in the "Vigyan Rail", an exhibition sponsored by Vigyan Prasar, Department of Science and Technology. The Vigyan Rail which was flagged off from New Delhi on December 15, 2003, will be travelling throughout the country for eight months. The ISRO coach includes the nuances of space science and technology, achievements under the programme, models of rockets and satellites, demonstration of satellite motion in orbit, besides a space quiz programme.

A view of ISRO coach in Vigyan Rail

Eager students queue up to enter Vigyan Rail

A dance scene during the cultural evening organised on the eve of GSDI-7