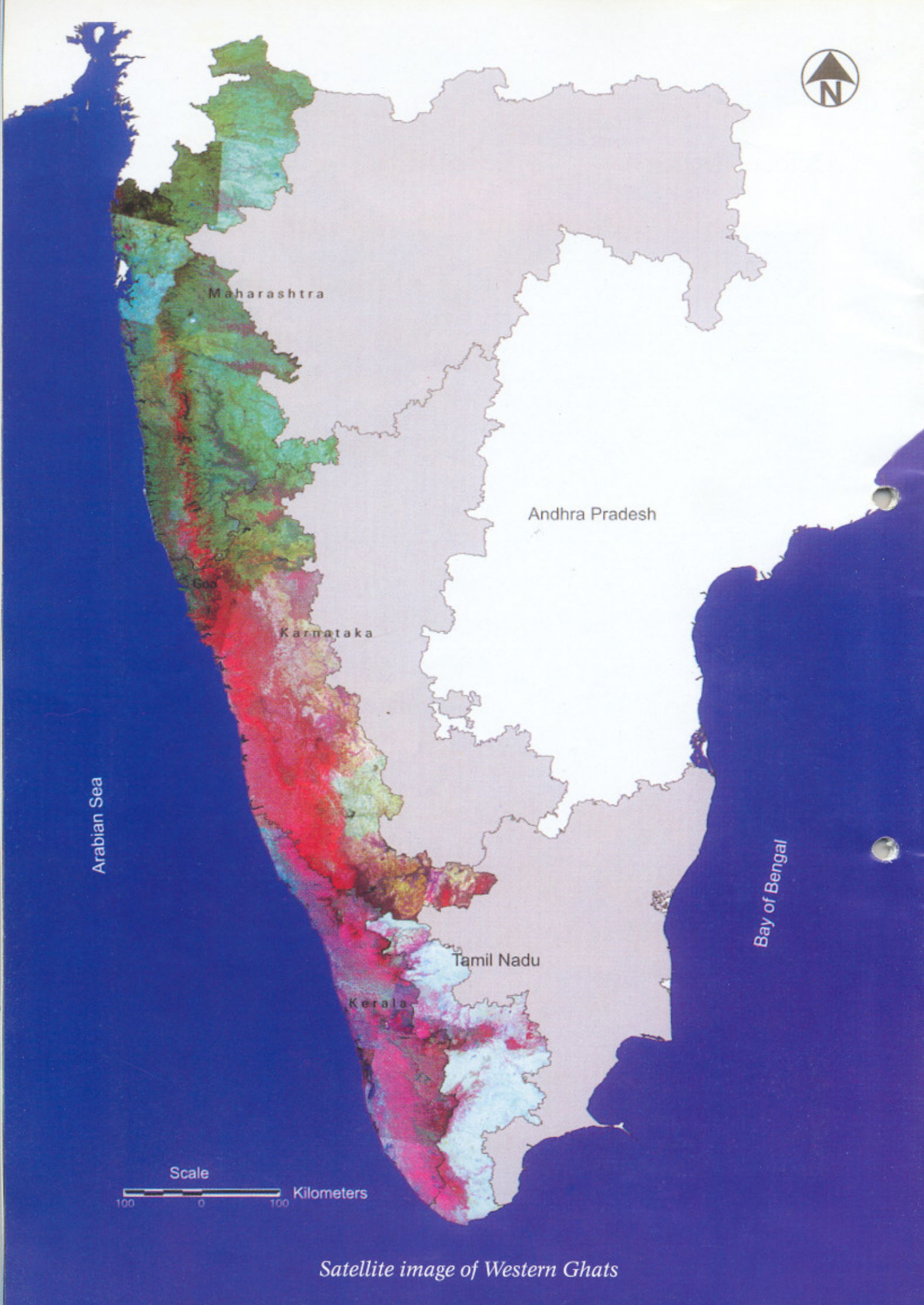
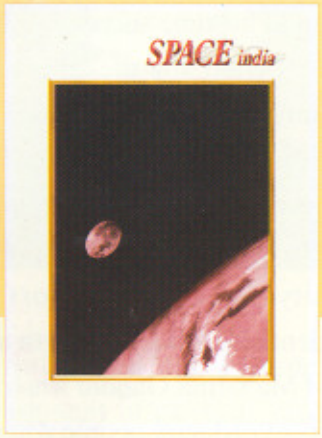
October-December 2002

SPACE india

INDIAN SPACE RESEARCH ORGANISATION



Satellite image of Western Ghats



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Cover Page:
METSAT captures the Earth and Moon together! This image was taken by Very High Resolution Radiometer on board METSAT, a week after its launch on September 12, 2002. The Moon appears oval-shaped due to its movement while being imaged. This image was received and processed at MCF, Hassan.

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Editorial / Circulation Office
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President Visits Vikram Sarabhai Space Centre, Thiruvananthapuram

It was a homecoming for the President of India, Dr. A P J Abdul Kalam, when he made a nostalgic visit to his former institution, the Vikram Sarabhai Space Centre at Thiruvananthapuram on November 18, 2002, to deliver the first Prof. Satish Dhawan Memorial Lecture. This was his first visit to Kerala after becoming the president. Dr. K Kasturirangan, Chairman, ISRO and Mr. G Madhavan Nair, Director of the Vikram Sarabhai Space Centre received the President. About 5000 employees from the ISRO Centres in Thiruvananthapuram waited anxiously to greet their former colleague.

In his address, Dr. Abdul Kalam spoke at length on "Vision and Leadership". He reminisced that his real education was at the sprawling expanse of the Vikram Sarabhai Space Centre more than in any University. He said that "the education we receive and our environment transform us into good human beings", and that he was fortunate to be associated with three great human beings – Dr. Vikram Sarabhai, Prof. Satish Dhawan and Dr. Brahm Prakash. The President recalled that Prof. Dhawan was a great leader with a vision and said that it was the confidence that a leader like Prof. Dhawan bestowed on his colleagues and his unstinted support that made all the projects undertaken in his time successful. While remembering the SLV-3 period and the failure of its maiden flight, Dr. Kalam said that a great leader owns responsibility for failures and gives credit for successes to his team members. Prof. Dhawan was one such great leader. In a nostalgic tone he thanked the ISRO community for their support and inspiration. The President also talked at length about the noble leadership of Mahatma Gandhi who chose to reduce the sufferings of ordinary people when the nation celebrated its independence in 1947.

Stressing the enormity of responsibility, which organisations such as ISRO have undertaken to fulfil the socio-economic aspirations of the

Sharing happy moments ...

The President with his former ISRO colleagues

underprivileged, the President urged the urgent establishment of physical, electronic and economic connectivity to the rural masses. Technology, not meant to be kept in cupboards, must be translated into benefits for the common populace as ISRO has so successfully demonstrated. Setting the next mission target of eradicating hunger, malnutrition and illiteracy for the 300 million living below the poverty line, the President identified knowledge, competitiveness and innovation as the crucial approaches for bringing in economic strength.

Recalling the heritage of technological leadership, the President called on ISRO to new initiatives, such as the cost effective space transportation, solar power for industry and rural areas, global positioning satellite system, probably a habitat in space and also a possible contribution to the connectivity of rivers.

The President, during this visit, also laid the foundation stone for the ISRO Training Centre at the VSSC premises. The Training Centre is designed to meet in-house training requirements covering all aspects of technological needs of all the ISRO Centres. The centre will impart induction training as well as in-service training to ISRO employees, an initiative undertaken by ISRO to institutionalise the smooth passage of knowledge and wisdom to the younger generation.

The President visited an exhibition on "New Technologies in Space" and later participated in interactive sessions with senior scientists from all the centres of ISRO.

Earlier, welcoming the President, Dr. Kasturirangan said that Dr. Kalam, along with his colleagues, has transformed the village of Thumba into a center of modern technology. He expressed his happiness on the President's decision to start his scientific pilgrimage from the establishment where he had worked for more than two decades.

Mr. Madhavan Nair, Director, VSSC, proposed the vote of thanks. He said that Thumba nurtured half a dozen directors, two chairmen and now, the President of India. He thanked the President and others for their participation.

Industries Produce Satellite Hardware

Since its inception, ISRO has been striving to involve the Indian industries in its space programme. With the substantial increase in the scope of the space programme, both in terms of the number of launch vehicles and satellites being developed and launched by ISRO, the efforts to involve the industry is receiving further fillip. The ISRO efforts are now aimed at making the industries graduate from supplying parts and components, to supplying major systems required for ISRO's satellites and launch vehicles.

Two successful cases of such ISRO-Industry interaction reported here are Heat-Pipes and Invar Filters.

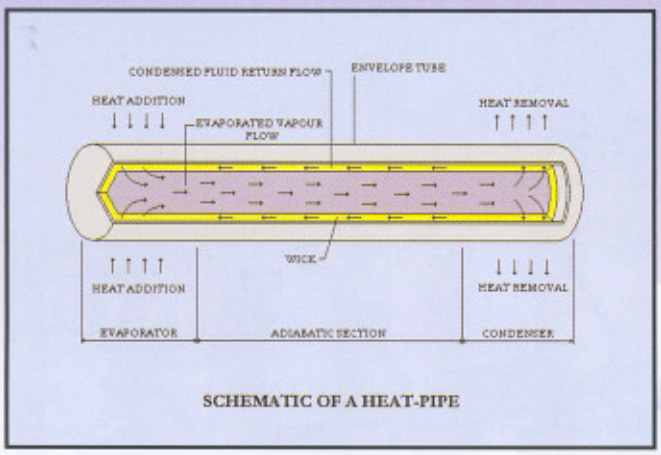
Heat-Pipes for Spacecraft Thermal Control

The electrical and electronic systems employed in satellites dissipate heat, which in turn, raises the system temperature. If the temperature is permitted to vary widely, the components' characteristics can change sufficiently and alter the behaviour of circuits, making it essential to control and maintain the temperature of different systems of the satellite within safe limits.

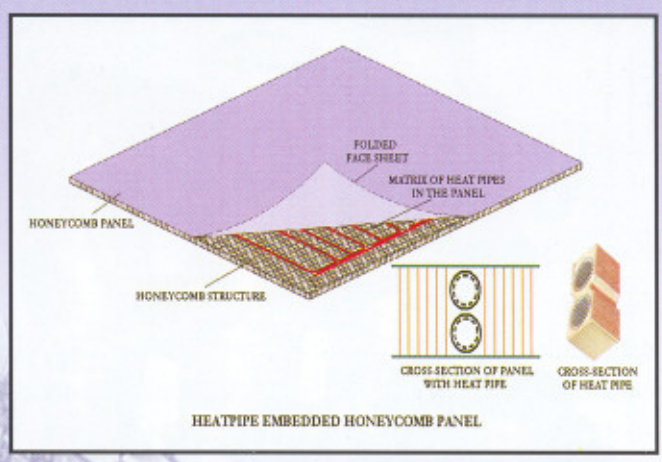
In most thermal control problems related to high dissipation components and subsystems of the satellites, metallic (aluminium) diffuser plates/heat sinks are generally used. These plates tend to be heavy. Being passive elements (diffuser plates), they are preferred for reliability.

But, with the ever increasing use of micropackaging and the consequent weight/volume constraints, heat dissipation per unit area and per unit mass of the system is also increasing in the present day spacecraft. Controlling temperatures of such subsystems (for example, TWTA, SSPA, etc.) within the safe limit becomes almost impossible with conventional passive temperature control elements and the use of active/ semi active systems becomes unavoidable.

The heat pipe is an efficient heat transfer device. Its thermal conductance is several hundred times better than that of the established good thermal conductor— copper. The high thermal conductance of the heat pipe is achieved by a two-phase heat transfer inside the heat-pipe. In its simplest form, it consists of a hermetically-sealed tube containing a capillary wick saturated with a two-phase working fluid. Heat input to any part (evaporator) of the heat-pipe is absorbed by vapourisation of working fluid and the evaporated fluid vapour flows in the core region which is colder (condensor). Here, the heat is rejected by condensation of the vapour and the condensed working fluid returns to the evaporator region of the heat-pipe from the condenser region, by capillary action in the wick and thus the cycle continues. The changes of working fluid phase in the heat-pipe — liquid to vapour and vapour to liquid — give the heat-pipe its high thermal conductance property.



SCHEMATIC OF A HEAT-PIPE



HEATPIPE EMBEDDED HONEYCOMB PANEL

Different kinds of wick structures like the cylindrical screen mesh wick, arterial wick, pedestal wick, axial groove wick, etc., are used to generate capillary pressure in the heat-pipe. Though axially grooved wicks are less efficient, considering reliability and long life, integral axially grooved aluminium extruded tube is used as an envelope and wick structure for satellite applications. Ammonia is used as working fluid because of its high latent heat of evaporation, low viscosity and temperature range of operation.

Heat-pipes were used for the first time in ISRO's INSAT-2E satellite. The heat-pipes which were embedded in the honeycomb equipment panels were thermally coupled to provide a nearly isothermal equipment panel irrespective of the location of heat-dissipating components and subsystems.

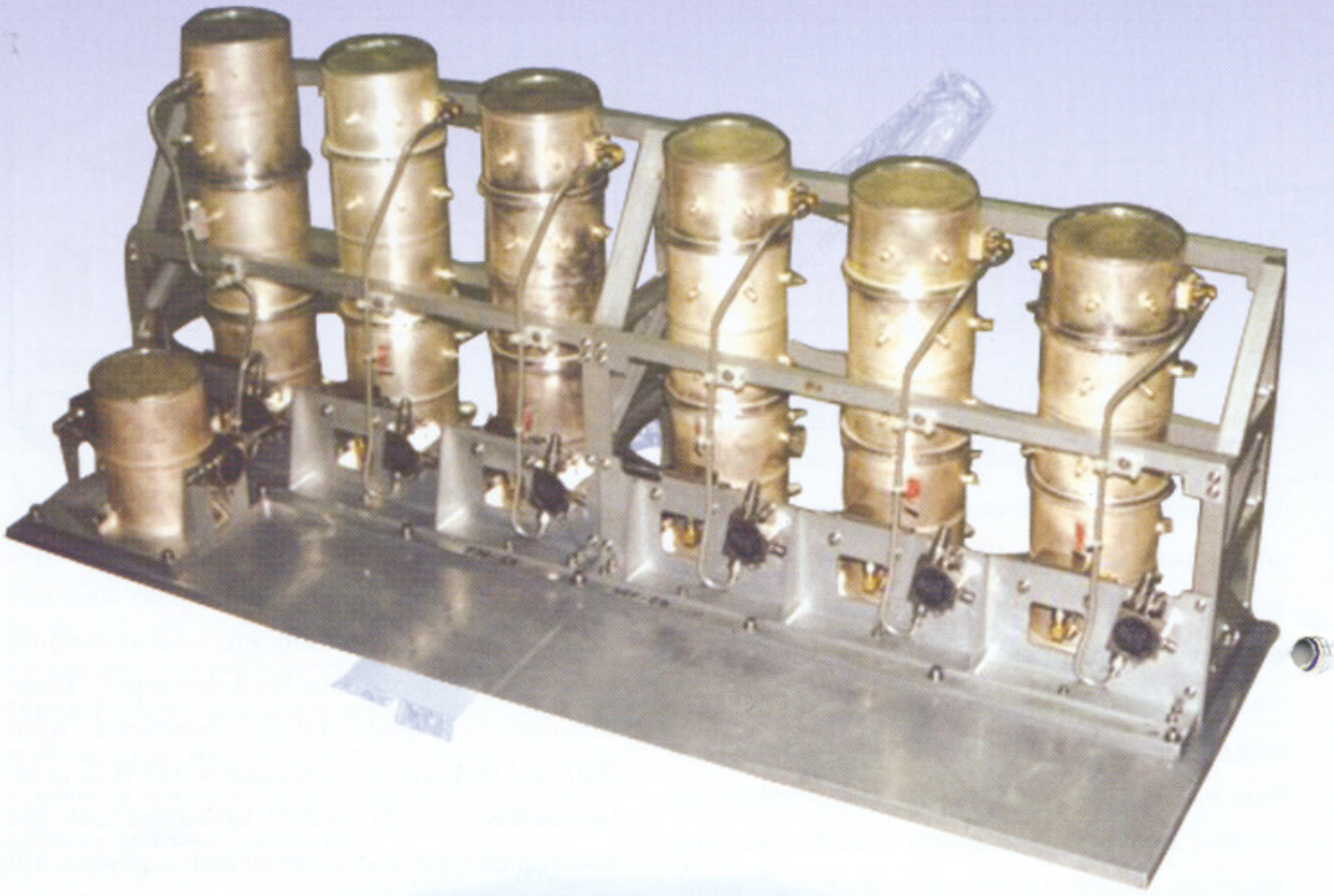
INDIGENOUSLY DEVELOPED DUAL CORE AXIALLY GROOVED ALUMINIUM AMMONIA HEAT PIPE

The axially grooved aluminium ammonia heat-pipes were developed by the ISRO Satellite Centre, (ISAC) Bangalore. Both single vapour core and double vapour core axially grooved aluminium ammonia heat pipes have been developed. These heat-pipes were used in GSAT-1, launched in April 2001 and they will be used again in GSAT-2, to be launched by GSLV-D2 in 2003. Embedded heat-pipe panels employing double vapour core heat-pipes will be used in INSAT-3A, which is also slated for launch in 2003.

With the continuous requirement of heat-pipes for the forthcoming satellites, the technology for the heat-pipes was transferred under a contract to M/s Elbeam Devices Limited, an Avasarala Group Company in March 2001 with ISRO providing technical and financial assistance for establishing fabrication and testing facilities for space grade heat pipes. The contract has borne fruit with space-worthy double core axially grooved aluminium ammonia heat-pipes having been successfully fabricated and undergone all the acceptance tests.

Communication hardware

At a brief function held on October 30, 2002 at Antariksh Bhavan, Bangalore, Bharat Electronics Ltd. (BEL), Bangalore, formally handed over Invar Filters to ISRO. These sophisticated precision components are to be used in the communication



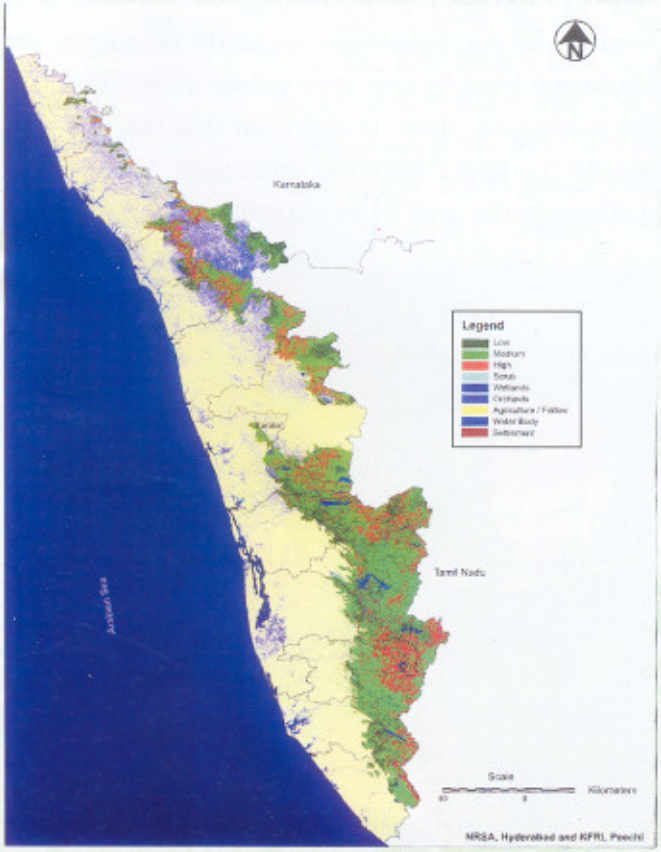
transponders of INSAT-3E and follow-on satellites. The Invar Filters were the first batch of space qualified components being fabricated by BEL under a contract with ISRO's Space Applications Centre, Ahmedabad.

BEL is also making C-band and Ku-band receivers for ISRO's communication satellites, which involve the use of microwave integrated circuits that need to be assembled under a clean environment. ISRO had transferred the technology for the Invar Filters and Receivers to BEL and also trained its personnel for their production. Besides this, ISRO has funded the setting up of specific facilities required for building space hardware, in addition to allowing BEL to use ISRO's facilities like the Electron Beam Welding facility. Besides satellite components, BEL will also be supplying ground terminal equipment like Mobile Satellite Services reporting terminals and L-band Demodulators to ISRO. It is expected that BEL will supply space hardware worth about Rs. 200 Crore in the next five years.

Biodiversity Characterisation Using Remote Sensing

Department of Biotechnology and Department of Space have jointly carried out Biodiversity Characterisation at Landscape Level covering the country's most important natural landscapes — the North Eastern Region, Western Ghats and Western Himalaya. The study, which was completed in October 2002, covers an area of about 84,000 sq. km — (46 percent of total forest cover of India) – a vast repository of economically and ecologically important plant resources. Particularly, the North Eastern Region and Western Ghats are categorised as the world's "hotspot" regions.

The digitised "Biodiversity Atlas and Database of India" was released by the Union Minister of Human Resources Development, Dr. Murli Manohar Joshi during the inaugural session of the 90th Indian Science Congress at Bangalore University on January 3, 2003.



Vegetation type map of Kerala

The study is based on intensive field sampling, knowledge base, mapping using satellite remote sensing and geospatial modeling tools. Satellite Remote Sensing has brought in a quantum improvement to the quality and pace of surveying.

The earth is a unique planet, teeming with hundreds of thousands of plant and animal species living in a variety of environment. The conservation of this wide variety of living things and their environment — the Biodiversity — is one of the greatest challenges facing humankind today, due to the large population growth and its consequent pressure on the environment.

> About 10 to 20 plant species provide 80 to 90 percent of the food requirements of the world.

Specifically, biodiversity conservation in the natural landscape is a key issue for sustainable management of forest resources. An environment, which is rich in biological diversity, offers the broadest array of options for sustaining human welfare and for adapting to change and evolution. Loss of biodiversity has serious economic and social costs for any country. India, which is the seventh largest country in terms of area, is one of the mega-diversity countries of the world and has various biogeographic regions supporting habitats with rich flora and fauna.

Today, about 10 to 20 plant species support 80 to 90 percent of the food requirements of the world.

Saraca asoca (Roxb) de Wilde, threatened medicinal species, South Canara, Karnataka

Specially in India, a considerable part of the tribal population's food demand is met by wild plants. The ancestral Indians obtained medicines through various plant resources. The knowledge about the medicinal value of plants has evolved in the form of traditional systems of medical sciences like Ayurveda, Unani, and Siddha.

More than 8000 plant species have been used in some 10,000 drug formulations. The global plant based drug trade is around Rs. 31 thousand crores (Rs. 310 billion) with a 7 percent annual growth rate, of which the Indian share is limited to 2.5 percent. However, loss of natural habitats have posed an alarming threat to the wild plant resources. As a consequence, certain species are at risk and the list is likely to grow. It is in this context, that creation of an authentic baseline data on biodiversity – of immense value in subsequent monitoring and analysis assumes significance.

Acquisition of images of earth from space has opened up new frontiers in mapping. The multi-spectral images of the earth captured by a satellite provide definitions of vegetation patches and plant communities occurring in a unique environmental set up. The imagery obtained from Indian Remote Sensing satellites have been effectively put to use for this biodiversity characterisation. Thus, for the first time, vegetation cover type maps, fragmentation in the forest area, disturbance regimes and biodiversity rich areas have been mapped on a 1:250,000 scale.

In this study, about 5,100 sample points distributed in different vegetation types as per the statistical sampling design, have been used to derive species variability, ecological status of medicinal plants, endemism and their ecological sensitivity. In addition, three important high-altitude medicinal plants, viz., *Ephedra gerardiana, Hippophae rhamnioides* and *Texus wallichiana* have been mapped. The medicinal importance of these species vis-à-vis altitudes at which they occur have been investigated.

A web-enabled database has been created, which links the gene level information on important plant species with the spatial distribution. The species database consists of information on taxon, accession, genetic information and bioprospecting importance. About 25 lead institutions and universities have been involved in this endeavor.

It is hoped that the findings of the study will lead to important tasks of planning, conservation of biodiversity and bioprospecting in the country at the landscape level by the appropriate authorities. At the same time, there is optimism that this will also benefit the larger scientific community of the world working in the area of biodiversity conservation.

Gloriosa superba L., a threatened medicinal plant species

A New Sounding Rocket Initiative for Middle Atmospheric Studies

A Rohini Sounding Rocket, RH-200, was launched on November 21, 2002 from the Thumba Equatorial Rocket Launching Station (TERLS) near Thiruvananthapuram, marking the commencement of a new series of rocket launches as part of the Middle Atmospheric Dynamics Science (MIDAS) Research programme. It was exactly 39 years ago, on this day, that the first sounding rocket was launched from TERLS, heralding the modern space era in India.

The MIDAS programme, which was inaugurated by Mr. G Madhavan Nair, Director, Vikram Sarabhai Space Centre with the first rocket launch, consisted of an elaborate observational programme of regular measurements of atmospheric temperatures and winds using balloons, ground based Radars and Laser instruments in addition to the fortnightly launches of RH-200 rockets for high-altitude wind measurements. During the next five years, the programme will study different aspects of middle atmospheric dynamics including the wave activity, stratospheric response to stratwarm events in the mutual coupling between the break monsoon phenomenon and the Middle Atmospheric Dynamics. The results from this programme have the potential of unravelling the different aspects of Indian monsoon and weather.

ISRO has developed a series of Sounding Rockets, RH-200, RH-300 and RH-560, which are regularly used for various scientific experiments. To date, about three thousand sounding rocket launches have taken place from India. The launch of RH-200 on November 21, 2002 as part of MIDAS launch programme is yet another important contribution from Sounding Rockets to the atmospheric research.

RH - 200 Launch

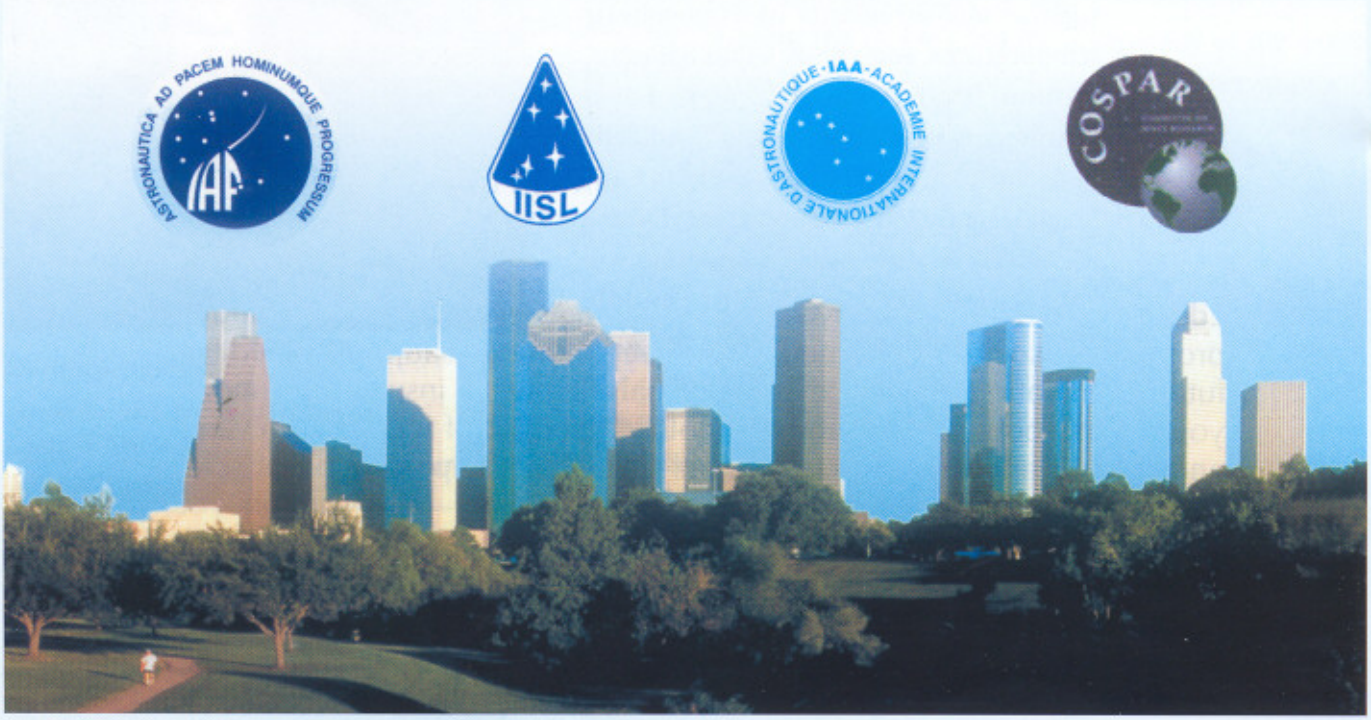
WORLD SPACE CONGRESS 2002

HELD AT HOUSTON, USA

Hailed as the largest scientific, technical and space exhibition event ever, the World Space Congress 2002 (WSC-2002), was held from October 10th - 19th, 2002 at Houston, Texas, USA. The Congress drew more than 20,000 participants to the hundreds of technical sessions, exhibits, conferences and educational programmes. According to the organisers, this once-in-a-decade event was a huge success based on the overall collaboration, exchange of information and public outreach. Hosted and organised by the American Institute of Astronautics and Aeronautics, WSC-2002 was held under the auspices of the United States National Academy of Sciences with the theme "The New Face of Space", WSC-2002. The events comprised of numerous activities designed to fulfill many missions.

The multitude of Congress components included the 34th Scientific Assembly of the Committee on Space Research (COSPAR), the 53rd International Astronautical Congress, the International Space Trade Exhibition and the education outreach programmes.

More than 4,000 delegates of COSPAR, the International Astronautical Federation (IAF), Space Operators and other organisations participated in the Congress and the associated events. Experts showcased cutting-edge science, engineering and technology research through more than 450



Houston Skyline

technical sessions hosted by COSPAR and the IAF. Topics included science, technology, infrastructure, missions and exploration, business and applications, legal and policy factors, education and history.

As a panelist, Dr. K Kasturirangan, Chairman, ISRO addressed the Plenary Session of 53rd International Astronautical Congress (IAC), titled "An integrated Approach to Monitoring Planet Earth: Marshalling satellite and *in situ* Observations for Users and Decision Makers" on October 15. He also participated in the plenaries on "Space Activities: an Engine for Serving Humanity", as well as "New Technology of Space Applications".

The SpaceOps 2002 Conference, held during October 9-12, gathered participants from all over the world, who discussed state-of-the-art operations principles, methods and tools for entities involved in space mission operations and ground data systems. About 50 percent of the technical papers were presented by delegates from countries outside the US. The importance and need for evolving standards enabling nations to work together and share resources was a loud and clear message emerging out of this conference.

The International Trade Exhibition engaged a total of 3,150 exhibitors from 350 companies and organisations, serving as the largest exhibition ever for the space industry.

The University of Houston played host to several education outreach events that drew more than 6,000 students. The educational programs were designed to instill excitement in children for mathematics, science and technology, as well as to equip educators with the tools they need to develop and enhance curriculum in order to impact the world's students positively.

Highlights included the Mars Rover competition, Space Rocks, Kids Festival and robotics demonstrations. The Mars Rover competition featured more than 40 entries of inert models, designed and constructed by primary and middle school students.

The 2002 Congress also marked the debut of the first-ever event — Space Policy Summit — hosted by the James A. Baker III Institute for Public Policy at Rice University on Oct. 10th-12th. This private forum offered a valuable opportunity for 39 international leaders from the government and from the industry of 16 nations to have an open and frank discussions in three main sessions: commercial space activities, space exploration and space applications. The Summit participants identified key policies and initiatives aimed at bringing the benefits of space to humanity, while eliminating the obstacles that inhibit taking full advantage of these benefits. The issues that emerged from the Summit include: The importance of cooperation in space to expand relationships between nations; the need to enhance the public awareness of the benefits of space; and the potentiality of space to inspire young minds towards mathematics and science, leading to long-term workforce benefits.

The International Trade Exhibition engaged a total of 3,150 exhibitors from 350 companies and organisations, serving as the largest exhibition ever for the space industry. The 350,000 sq. ft exhibition featured a combined large country/industry/agency pavilion presence from Austria, China, France, Germany, Holland, India, Italy, Japan, Poland, Sweden, United Kingdom, etc., with industry representation from Canada and the U.S. that attracted more than 7,000 people during the trade and public days.

"India in Space" Pavilion

India put up an impressive pavilion "India in Space" which turned out to be a star attraction. The pavilion

"India in Space" Pavilion

brought the significant progress made by India in remote sensing, satellite communications, launch vehicles and space applications, to the notice of the world space community.

The 2000 sq. ft. pavilion enjoyed the participation of ISRO and ANTRIX, besides 16 entrepreneurs/ industries in India who are contributing to the Indian space programme. These include: Avasarala Automation, Bharat Electronics, Bharat Heavy Electricals Limited, Apollo Hospital, Hindustan Aeronautics Limited, GNFC, On-line Telemedicine, MTAR, Larsen and Tubro, National Remote Sensing Agency, Speck Systems, Worldspace India, Sanmar Micropack and Semiconductor Complex. The US company Space Imaging, the marketing agency for Indian remote sensing satellites data, also took part in the "India in Space" pavilion.

The exhibition comprised of 44 display panels, about 36 products and 6 models of Indian launch vehicles and satellites. The 1:10 scale models of the Indian launch vehicles, PSLV and GSLV, dominated the Indian pavilion. The visitors to the Indian space pavilion included registered participants to the IAF Congress, a number of space hardware manufacturers, businessmen, students and the general public.

As evident from enquiries, the visitors evinced keen interest in launching small satellites using India's Polar Satellite Launch Vehicle, entering into partnership with ISRO for manufacturing space hardware, obtaining more information on India's latest exclusive Meteorological satellite (METSAT) and the proposed lunar mission. the "India in Space" pavilion was a very successful event, in that it provided an exposure to the Indian space programme amongst the world space community.

Vikram Sarabhai Award for Prof. Rong-Lan Xu

The ISRO-COSPAR Vikram Sarabhai Award for the year 2002 was conferred on Prof. Rong-Lan Xu of the Chinese Academy of Sciences, Beijing. The award was presented on October 15, 2002 at a function organised by the Committee on Space Research (COSPAR), during the World Space Congress-2002 at Houston, Texas, during October 10-17, 2002.

Prof. Xu, who graduated from the Department of Physics, Beijing University, China in 1958, worked for several years at the Institute of Geophysics, Chinese Academy of Sciences. He rose to become the Head of the Department and Research Professor of the Institute of Space Physics that was renamed as the Centre for Space Science and Applied Research, Chinese Academy of Sciences, Beijing. He has also held many important positions in academic and research institutions and has provided valuable guidance to several professional societies, committees and organisations. He was one of the first scientists in China to participate in COSPAR and became the contact person of China for COSPAR through his membership in COSPAR Panel on Space Research in Developing Countries (PSRDC). He participated in the guest observation programme of International Sun-Earth Explorer (ISEE) spacecraft as part of an international cooperative venture and made notable contributions in evolving the magnetospheric neutral sheet model.

Some of the highlights of Prof. Xu's research activities are: laboratory experiments in space plasma elucidating variation of radiation belt phenomenon during magnetic disturbances, particle pitch angle scattering as the mechanism of particle precipitation during magnetospheric substorm and the development of Geiger counter energetic particle detector on board the first Chinese scientific satellite (SJ-1) launched in March 1971. They also include various rocket experiments, using satellite data for studies related to spatial distribution of energetic particles, current sheet and acceleration processes in the magnetotail leading to his well documented Magnetospheric Neutral Sheet Model. He has over 80 publications in refered scientific journals.

Prof. Xu is also involved in the planning of the chemical release experiment programme by conducting various computer simulation studies on barium cloud evolution and its asymmetric structure. He has proposed a China-Russia joint balloon experiment for ozone generation and regeneration using electron gas discharge gun and the chemical release device.

The Vikram Sarabhai Award, instituted in 1990, is conferred jointly by COSPAR and ISRO in honour and memory of Dr. Vikram Sarabhai, who pioneered the space research activities in India. Awarded every alternate year to recognise outstanding contributions made by individual scientists to space research in developing countries, it consists of a medal and a citation. The earlier recipients of the award are Academician Kotelnikov of Russia (1990), Prof. C Y Tu of China (1992), Prof. Blamont of France (1994), Prof. U R Rao of India (1996), Dr. James Baker of USA (1998) and Dr. Zhen Xing Liu of China (2000).

Dr. K Kasturirangan, Chairman, ISRO reading the citation

Syzygium laetum (Har) Gandhi., endemic and vulnerable species, South Canara, Karnataka