

planning activities in agriculture, land and water resource management, watershed development, forestry, disaster management, infrastructure and educational activities.

The students then visited Indroda Nature Park, being developed by Gujarat Ecological Education and Research Foundation. During the nature walk, they visited the Dinosaur park, aviary, crocodile park, deer park, botanical garden, etc. and also interacted with the scientists at these centres. In the afternoon, the students were back at the venue of Science Congress for the valedictory function. Prior to that they attended the Vigyan Jatha activities conducted by Regional Community Science Centre, Rajkot.

The entire event in the sprawling, undulating landscape of the Science City offered these budding scientists a rare opportunity of exploring the wonder world of science and technology. Along with showcasing their exhibits, the student delegates interacted with other students, experienced the thrill of watching 'T-

Rex: Back to Cretaceous', an IMAX 3D movie and walked through different theme pavilions of the Gujarat Science City. 'It was a wonderful experience and a dream place', many of them quoted while leaving the Science City campus.

'The entire process is to enthral the young mind for the basic curiosity, which is the driving spirit for the growth of science. I have a strong belief that scientific knowledge and scientific temper, both form a right combination and are the key for development', remarked J. N. Singh (Secretary, DST, Govt. of Gujarat).

The programme aimed to create excitement and enlightenment about science and provide opportunities for young children to explore challenging areas of study in science and technology. The Children Science Congress is also an occasion for budding scientists to learn about new discoveries and recognize that a career in science is rewarding.

The activities during the Children Science Congress were also witnessed by thou-

sands of other students who were visitors to the Gujarat Science City. The Science City had also arranged for the live telecast of specific events on its newly installed large LED screen for mass-viewing.

'Man's journey of life in this world is wonderful. Science is a journey toward the truth and we know that truth will make everybody fresh and free. The study of nature, through multiple disciplines of science, makes it all the more exciting and fascinating. Every student of science can experience this excitement if he or she asks the right questions and seeks a logical answer to each of the questions', said S. D. Vora (Executive Director, Gujarat Science City).

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Aerosols, clouds and monsoon

The International Symposium on Aerosols, Clouds and Monsoon was attended by about 120 delegates from various parts of India and also ten foreign scientists from USA, Japan, Germany, Taiwan and Greece. Nearly 120 extended abstracts were made available at the time of registration.

The fact that over the last ten years, significant changes in climatic and weather conditions have taken place over the Indo-Gangetic basin, was the reason behind organization of this symposium. P. C. S. Devara, Vice-President, Indian Aerosol Science and Technology Association (IASTA) briefed about the objectives, activities and future plans of IASTA and welcomed the delegates.

Sanjay Dhande, Director, IIT Kanpur, in his Presidential address, invited scientists to solve problems of dense fog and haze over the Ganga basin, which are common

during December and January. V. Ramanathan, Victor C. Alderson, Professor of Ocean Sciences, USA gave the inaugural lecture on 'Air pollution, atmospheric brown clouds and the Indian monsoon'. He highlighted the findings of the INDOEX experiment and also provided details of the Asian brown cloud (ABC). Ramanathan stressed the need for atmospheric observations. He emphasized the influence of greenhouse gases (GHGs) on climate through the solar incident energy, solar reflected energy and earth's emitted energy. The GHGs have increased significantly after 1950s, leading to significant influence on: dimming of the planet, sea surface temperature, and cloud formation and rainfall.

It is estimated that India is about 6–7% darker now than in 1950 due to the influence of GHGs. Ramanathan gave details of ABC, which was discovered during the INDOEX experiment and noted that India should be concerned with ABC.

In the first technical session on 'Aerosol research: Global perspective' five papers were presented. Brent Holben (NASA, USA) reviewed the global Aeronet network of NASA and several research accomplishments by various groups in integrating

the research data and derived products. C. B. S. Dutt, Coordinator, ISRO–GBP programme gave details about the IGBP programme of ISRO that has laid emphasis on aerosol studies for over a decade. He referred to the field campaigns over marine and land regions of India and to the commitment of ISRO to promote aerosol studies in an integrated manner among Indian research institutes.

Sanjeeva Rao, Department of Science and Technology (DST), New Delhi summarized the efforts made by DST in promoting atmospheric research through project mode funding and organization of several field programmes such as MONTBLEX (1990), CASPEX (1995–96), BOBMEX (1999) and ARMEX (2002–03) and the climate programme. K. Krishnamoorthi (VSSC, Thiruvananthapuram) reviewed the work carried out at the Space Physics Laboratory at VSSC on aerosol in the last 15–20 years. He also gave an account of the contributions made by the Indian scientists under the INDOEX programme. He illustrated the nature of radiative forcing over India in different seasons. Krishnamoorthi presented plans by ISRO in extending the sun photometer network at 22 locations

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to cover large parts of India and building a national aerosol data centre in the next few years. Terry Nakajima (Japan) covered the fundamental aspects of aerosol science and its importance in understanding the earth's deviate surface. He discussed the importance of proper estimation of radiative forcing due to anthropogenic aerosol in the Asian region because of the rapid growth of population and industrialization in this region. A SKYNET network similar to AERONET has been established in East Asia to understand the anthropogenic impact on climate comprehensively, as the Asian aerosols are highly heterogeneous in chemical and optical characteristics. He also referred to the importance of the SKY radiometric network in India at Pune and emphasized the importance of the Kanpur station in this network, representing Indo-Gangetic basin region.

In the second technical session on 'Climatic effect and radiative forcing', R. T. Pinker (USA) dealt with the importance of radiative flux as one of the major functions of the energy budget, which is still the most uncertain parameter in climate studies. There is need to measure this accurately, especially over India in terms of growing pollution. S. Singh (NPL, New Delhi) presented his studies on variation of the aerosol optical depth and angstrom coefficients over Delhi during clear sky radiation dust-storm periods.

In the third session on 'Aerosol chemistry and fog characterization', S. N. Pandis (USA/Greece) presented the interaction of particulate matter with water in clear condition, cloudy and foggy atmosphere and its representation in a 3D model. An automated system has been developed to carry out experiments in different ambient meteorological conditions.

The fourth technical session on 'Surface and atmospheric ozone' had Shyam Lal (PRL, Ahmedabad) discussing the surface ozone trend over different rural and urban regions in India. As the main coordinator of the land campaign, he showed some of the results during the first land campaign which covers the southern part of India and also discussed about the plan of the second phase of the land campaign which would be held during December 2005. This would cover the northeastern part of India, mainly the Gangetic plain from Delhi to Kolkata. The main aim of this campaign in the Indo-Gangetic plain is to understand the dynamics of the atmospheric aerosols, ozone and its precursors. G. Beig (IITM, Pune) discussed the surface ozone and

various pollutants like NO_x , CO, VOCs, etc. and showed an emission model based on Geographical Information System. He also showed the behaviour of surface ozone and its precursor gases over Pune. Efforts made by Beig's group in maintaining a website (ENVIS) which provides data on ozone and its precursor gases were highlighted. Based on long-term measurements, the safest concentration of surface ozone over the Indian region is about 87 ppmv.

Papers dealing with the declining trend of ozone in Antarctica, aerosol measurements at the high altitude station in Nainital and on the laboratory study for characterization of heavy metal content of particulate matter from a diesel engine were presented.

The fifth technical session began with a talk by Pratim Biswas (USA) on Bio- and radioactive aerosols and nano-particles (1.0 to 100 nm). His presentation focused on synthesis of nano-particles in furnace and flame reactors and also brought out application of nano-particle technology to environmental technology and pharmaceuticals. Biswas also discussed the results of his experiments on $\text{PM}_{2.5}$ concentration and composition variation in highway traffic leading to air pollution problems, particularly due to low spatial variations. B. K. Sapra (BARC, Mumbai) presented an interesting paper on size distribution characteristics of some therapeutic nebulizers manufactured in India for bronchodilators. While suggesting to concentrate on fine particles sizes $< 1 \mu\text{m}$, she also suggested to focus on patient-related factors while manufacturing such nebulizers. Rajdip Bandyopadhyay (IIT, Kanpur) discussed about the dynamics and chain aggregates of carbon nano-particles synthesized by laser ablation, in laboratory experiments. He suggested a mechanism of reinforcement of composites in general and carbon-balance nano-composites in particular. Virendra Sethi (IIT, Mumbai) made a presentation on implications of aerosol dynamics with varying time temperature history on positioning of particulate control devices in engine tail pipes. Sethi and co-authors have used log-normal model to predict particulate size distribution along the length of tail pipes and have arrived at some interesting conclusions. A paper dealing with performance of sampling devices, namely, MOUDI and single-stage impactor for $\text{PM}_{2.5}$ in producer gas from thermal biomass gasifiers was presented.

P. C. S. Devara (IITM) presented an invited talk in the sixth technical session

on 'Remote sensing of aerosols and cloud'. He discussed the seasonal variation of aerosol parameters from satellite (TOMS index) data, and aerosol optical thickness and Ångström exponent from sun/sky photometry. The aerosol parameters show a large variation between pre- and mid-monsoon periods; the aerosol size distribution and optical characteristics are significantly affected by the climate regime of the region. Furthermore, they show a long-term variation depending on the year. There is need for detailed analysis of direct effect of dynamic flow change and indirect aerosol change due to atmospheric condition change. Harpalare *et al.* presented a technique of characterizing aerosols by Raman spectroscopy at Ahmednagar. The method has proven useful for identifying various aerosol chemical species and is sensitive enough for atmospheric aerosol measurements. The need to compare or validate the results with those from other techniques such as ion-chromatography was suggested.

Saha and Krishna Moorthy (VSSC) presented a time series of aerosol optical thickness and size distribution retrieved from sun-photometer measurements. The aerosol optical thickness is found to decrease significantly after two rainfall events and corresponding aerosol size distributions also changed with characteristic reduction at some specific particle size ranges. R. P. Singh (IIT, Kanpur) presented a paper on the impact of aerosols over India; he showed a significant impact of growing pollution and dust events which are likely to affect rainfall and cause the decline of total ozone column over the Indo-Gangetic basin.

The session devoted to air pollution studies was chaired by Chandra Venkaraman (IIT Mumbai) and M. K. Tiwari (NPL, New Delhi). Indira Joshi (IITM, Pune) presented a paper on the possible impact of volcanic aerosols on the southern hemispheric stratosphere warming during 2002. It was concluded that the warming was triggered by sulphur aerosols and also that this could be one of the responsible factors for splitting of the ozone hole this year. Arun Srivastava (JNU, New Delhi) presented preliminary results from six sites monitoring SPM size distribution in Delhi. The need for additional sampling to bring out seasonal and site-specific source allocation differences was emphasized. Seasonal comparison with data from Agra city was made. Use of lidar to assess mixing layer height was

discussed by Manoj K. Srivastava (NPL). Chandra Venkataraman (IIT, Mumbai) presented work on carbon and CO source inventorization of forest fires and biomass burning over entire India using satellite data and vegetation statistics. In a related work, Gazala Habib (IIT, Delhi) presented results from emission factor determination from traditional stoves. V. J. Daoo (BARC) presented the outcome of empirical modelling to forecast summer rainfall using part-year rainfall data. Sagnik Dey (IIT, Kanpur) presented results from Aeronet data analysis and also emphasized the need to re-look at the MODIS algorithm for dust-loaded sites. Sanjay Limaye (USA) highlighted the opportunity for partnership with School Science-Education Programme. He emphasized the need for real event data (e.g. from satellites) and introduction to innovative experimental methods to attract young minds to science.

In the last technical session on 'Atmospheric aerosol characterization' a number of papers were presented related to aerosol characteristics due to forest fires, urban and semi-urban practices and also due to dust and coastal emission. In the symposium, 33 poster presentations were made by young students dealing with laboratory, field and satellite studies.

During the symposium, two panel discussions were arranged. The discussion on data sharing was held on 16 November 2004. The panelists were D. R. Sikka, V. Ramanathan, Chandra Venkataraman, Sanjeeva Rao, Brent Holben, Terry Nakajima, Shyam Lal and K. Krishnamoorthi, comprising scientists from national and international agencies who are responsible for the aerosol data. Sikka (DST) while opening the discussion, said that data sharing in India has been a much-debated subject and a ticklish one too. Bulk of the operational meteorological data and satellite data is utilized by departments like India Meteorological Department and the Department of Space; there have been difficulties expressed by scientists outside these departments in acquiring data for research. This has been a major handicap. The campaign mode data were acquired under the DST sponsored monsoon-related field programmes, which created specific

data centres and the data were freely made available to atmospheric-ocean science community within two-years of completion of the experiments. Sikka mentioned that this has not been handled satisfactorily with regard to field campaigns on aerosol-chemistry, either under INDOEX or in IGBP-related field experiments. It was pointed out that the studies carried out in India are mostly based on internet or meteorological re-analysis projects by the US, European and Japanese agencies.

Ramanathan (USA) said that the entire INDOEX data acquired under the NSF Project was available on the website of the UCAR, and that anyone could use their data.

Chandra Venkataraman (IIT, Mumbai) pointed out that a website set up for Indian INDOEX data did not function satisfactorily. She expressed the need by creation of aerosol-related data centres in India and suggested that centres like CDAC could be involved as a facilitator for data storage and distribution. Field-campaign related data have a short-use period and best results from data collected during field campaigns are obtained if they are processed and distributed within almost two-years of the field campaigns in a systematic manner.

Holben (NASA, USA) shared his experience with regard to CIMEL network operated by NASA and mentioned the quality control procedure for data from this network. Data from this network are available through Aeronet sites. He stated that science programmes funded in USA ensure that the data are available in the public domain within about two-years of data collection. In this manner, data and even the products derived from such data are used by the larger scientific community. He stated that it has taken time and money in evolving such procedures in USA, with huge scientific benefits to the larger community.

Nakajima related his experience with development of the East Asian network with regard to earth radiation budget, GAW radiation, BABMON data, etc. He said that a major effort in terms of resources is needed for building up such a network. He agreed that it would go a long way in promoting data utility, if a specialized data centre for aerosol-related data is set up in India.

After a detailed discussion, the following consensus emerged:

- Culture of data sharing among scientists must be developed; such an approach will increase aerosol-related research.
- Funding agencies in India must ensure that data are available to them for distribution to interested scientists.

The panel discussion on atmospheric science education in institutes of higher learning had Sanjay Limaye, Chandra Venkataraman, S. C. Garg, D. R. Sikka and Vinod Tare. The main aim of this panel was to discuss the focused theme in relation to promotion of atmospheric sciences in tackling environmental problems and how the institutes of higher learning can include this area as part of the curriculum teaching of engineering subjects in the wake of the increasing role of atmospheric sciences in the study of the environment. The panelists made the following suggestions:

- Need for introduction of multidisciplinary areas like atmospheric sciences in undergraduate education in India.
- Specialized branches of atmospheric science like geophysical, fluid dynamics, mathematical modelling, earth radiation budget, climate studies and modelling like climate change, hydrology and study of atmospheric water cycle and its modelling, atmospheric/environmental pollution, and atmospheric technology may be introduced during the first-year course of engineering disciplines.
- Need for summer schools on atmospheric sciences in the country and exposure of young students to various national facilities.
- Research facilities related to atmospheric sciences may be enhanced in engineering colleges.

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