

*IASTA Meeting and International Conference on:*  
**Aerosols, Clouds and the Indian Monsoon**  
November 15 – 17, 2004  
**Indian Institute of Technology Kanpur**

**Summary of the Proceedings and Recommendations**

**Inauguration**

Monday, November 15, 2004; 09:15 – 10:30 h

Dr Vinod Tare, Convener, IASTA Meeting and International Conference welcomed the gathering and gave genesis of organizing the IASTA Meeting and Conference on the theme: Aerosols, Clouds and the Indian Monsoon at IIT Kanpur. Dr P C S Devara, Vice President, IASTA described the role of IASTA in furthering the cause of aerosol science in India. Dr S N Tripathi, Convener, Technical Programme stated that the call for submission of scientific papers received overwhelming response and after thorough review of papers 57 papers have been scheduled for oral presentation during the coming three days under eight Technical Sessions devoted to various sub themes of the conference. He also stated that 12 invited lectures by eminent persons from India and abroad will be delivered in various sessions and 42 poster papers will be displayed in the Poster and Exhibition Enclosure adjacent to the venue of the Technical Sessions. Professor S G Dhande, Director, IIT Kanpur welcomed all dignitaries, delegates and guests attending the conference on behalf of the institute and briefed on vision and activities of the IIT Kanpur on environmental engineering and science education and research in general, and aerosol and atmospheric sciences in particular. Dr V Ramanathan, Professor of Climate and Atmospheric Sciences, La Jolla, California, USA inaugurated the conference and delivered the talk on Air Pollution, Atmospheric Brown Clouds and the Indian Monsoon. In his address, Professor Ramanathan gave an overview of Atmospheric Brown Cloud project, popularly known as ABC Project, and its impact on the world in general and on India in particular. His presentation gave an overview of the physical links operating between the increasing pollution and rain suppression. The conference pre proceedings published as IASTA Bulletin, Volume 16, Nos 1 & 2 was formally released by Professors V Ramanathan and S G Dhande.

**Technical Session I - Aerosol Research: Global Perspectives**

*Chair: Dr D R Sikka*

Monday, November 15, 2004; 11:00 – 12:30 h

The session was devoted to global and national aerosols monitoring programs which were initiated in the last decade or so. The session included three invited talks. The first invited talk by Dr Brent Holben, USA, gave an overview of the federated aerosol robotic network (AERONET) initiated by NASA GSFC and summarized the achievement of Aeronet in advancing the understanding of regional aerosol optical characteristics and future challenges. The second invited talk by Professor Takashi Nakajima, Japan, focused on the monitoring of aerosols in Asia using SKY network and the need of greater understanding of anthropogenic aerosols and their climatic effects. The third invited talk delivered by Dr K Krishnamoorthy, VSSC, Trivendrum, presented an overview of the temporal and spatial variation of aerosols over India monitored by

MultiWavelength Radiometer (MWR). Besides the three invited talks, two representatives of major funding agencies viz. DST and ISRO made presentations on the programs initiated by these agencies related to atmospheric sciences.

## **Technical Session II: Climatic Effects and Radiative Forcing**

*Chair: Dr Pratim Biswas*

Monday, November 15, 2004; 14:30 – 16:05 h

This session was primarily concerned with the radiative effects of aerosols and its climatic implications. The invited talk by Dr Rachel T Pinker, USA dealt with the methods to assess the aerosol effects on the surface radiation budget controlling the latent and sensible heat flux that in turn influences the hydrological cycles. Several speakers presented the estimates of surface radiative fluxes in New Delhi and Pune and discussed its implications in climate change. Changes in the cloud radiative forcing over India using Earth Radiation Budget Experiment and the results of a first GCM simulation of aerosols over India were also presented. A couple of suggestions were made related to the validation of GCM results.

## **Technical Session III: Aerosol Chemistry and Fog Characterization**

*Chair: Dr K Krishnamoorthy*

Tuesday, November 16, 2004; 09:00 – 10:25 h

Aerosol and fog chemistry and aerosols interaction with water was the theme of this technical session. The invited speaker, Dr S N Pandis, USA, discussed the complexities of interaction of water with particulate matter and underscored the need to understand them. This is particularly important to understand aerosols growth as cloud condensation nuclei. Measurements of fine particles in New Delhi were also presented. Ion induced nucleation parameterization of water-euphoric acid particles, which is crucial for understanding the link between aerosol and cloud microphysical processes and ionization, was subject of another presentation. Doubts were raised about the application of water-sulfuric acid nucleation model in the atmosphere where sulfuric acid particles are the predominating particles. Couple of papers dealt with the chemical characterization of rain and fog water in the country.

## **Technical Session IV: Surface and Atmospheric Ozone**

*Chair: Dr Sanjay Limaye*

Tuesday, November 16, 2004; 11:00 – 12:45 h

This session started with an invited talk by Dr Shyam Lal, Physical Research Laboratory Ahmedabad. He gave an overview of the surface ozone over India. The spatial and seasonal variation in surface ozone was related to the changes in its precursor and sun light. He mentioned that presently few observations are being made and emphasized the need for more surface ozone observations in the country. Following this another related paper dealing with the ozone in Indian scenario was presented which dealt with the long time surface ozone observations over Pune. After this the session theme shifted from tropospheric to stratospheric ozone with few papers dealing with ozone hole over Antarctica were presented. Use of satellite data in ozone monitoring was the subject of another paper. An interesting paper was related to the characterization of soot particles emitted in diesel exhaust.

## **Technical Session V: Bio- Radioactive Aerosols, Nano Particles**

*Chair: Dr P C S Devara*

Tuesday, November 16, 2004; 16:00 – 15:50 h

In this session an invited talk by Dr Pratim Biswas, USA and five contributed papers were presented. Invited speaker gave an overview of nano-particle technology which is emerging as a novel fact in the Aerosol Science and Technology. His presentation focused on the synthesis of nano-particles in furnace and flame reactors. His presentation also brought out the application of nano-particle technology to environmental and pharmaceuticals fields. During another presentation he discussed the results of measurements on PM<sub>2.5</sub> concentration and composition variations in highway traffic leading to air pollution problems particularly due to low spatial variations. An interesting paper was presented on size distribution characteristics of some therapeutic nebulizers manufactured in India for administering bronchodilators, which have size range of 2-6  $\mu\text{m}$ . While suggesting to concentrate on fine particles (sizes < 1 $\mu\text{m}$ ), authors also suggested to focus on patient related factors while manufacturing such nebulizers. Another speaker discussed about the dynamics and chain aggregates of carbon nano-particles synthesized by laser ablation from laboratory experiments. The results mainly focused on dynamics of aggregates structures, namely nano-particle chain aggregates (NCA). Authors suggested a mechanism of reinforcement of composites in general and carbon-balanced nano-composites in particular. A presentation was made on implications of aerosol dynamics with varying time temperature history on the positioning of particulate control devices in engine tailpipe. The authors have used log-normal model to predict the particulate size distribution along length of tailpipe and arrived at some interesting conclusions.

## **Technical Session VI: Remote Sensing of Aerosols and Clouds**

*Chair: Dr Chandra Venkatraman*

Tuesday, November 16, 2004; 16:45 – 17:15 h

In this session two papers were presented. The first paper was a synthesis of aerosol data using multiple remote sensing techniques. It showed the variation in the aerosol parameters during successive monsoon seasons. The second paper dealt with the mapping of aerosol parameters using IRS data. Indeed there are several sensors e.g. NOAA AVHRR, TOMS, MODIS, which are measuring the aerosol parameters for some time, and can be easily utilized to study the spatial and temporal variations of these parameters.

## **Technical Session VII: Air Pollution**

*Chair: Dr M K Tiwari*

Wednesday, November 17, 2004; 09:00 – 12:45 h

This session was held in two parts. In the first part, Dr Sanjay Limaye, in his invited talk highlighted the opportunity for partnership with School Science-Education Programme, access to real event data (e.g. from satellites) and significance of innovative experimental methods for attracting young minds to science. The contributed papers focused on carbon pollution with an analysis of sources of aerosols and their chemical constituents. Aerosol instrumentation was analyzed as related to measurement of radioactive aerosol and aerosol volatile fraction.

In the second part of this session, the first paper examined the possible impact of volcanic aerosols on the southern hemispheric stratosphere warming during 2002 and conjectured that the warming was triggered by sulfur aerosols and also that this could be one of the responsible factors for splitting of ozone hole this year. The second paper presented preliminary results on SPM size distribution in Delhi based on measurements from six monitoring stations. Additional sampling to assess seasonal variations and site specific source allocation differences was suggested. Another paper dealt with a study in Switzerland that used Lidar to assess mixing layer height. It was found to be useful and suggestions were made to disseminate the technique for trials at suitable LIDAR sites in India. A very important work was presented on carbon and CO source inventarization of forest fires and biomass burning in entire India using satellite data and vegetation statistics. It was argued that there are not many ground truth exercises in India and results of such experiments by other research groups may be used to validate the results of the inventory. In a related paper, results from emission factor determination from traditional stoves, was presented. One presentation was outcome of empirical modeling to forecast summer rainfall using part year rainfall data. Dr Sikka emphasized on need to strengthen such studies to predict extreme rainfall years. Comparison of Aeronet measured AOD with MODIS were presented. This brought up the issue to re-look at the Modis algorithm for dust loaded sites. Dr Brent appreciated this important observation.

### **Technical Session VIII: Atmospheric Aerosol Characterization**

*Chair: Dr B K Sapra*

Wednesday, November 17, 2004; 14:00 – 16:30 h

In this session papers dealing with aerosol characterization were presented. First paper presented some important results obtained, by ground monitoring station, at a high altitude station, Nainital. The results of this paper are particularly important from the point of view of contrast in aerosol optical depths observed between a polluted urban location and a clean hill station. Another paper summarized the optical properties of aerosols in eastern region. Black carbon concentration over Arabian sea was subject of another paper. Two papers were also presented dealing with the diurnal variation of soot particles in Hyderabad city. One very interesting paper dealt with the ground level observation of mesospheric meteoric dust using twilight photometry. Dr Brent Holben, USA was quite interested in this technique and felt that this technique could be used to measure stratospheric aerosol optical thickness from aeronet.

### **Panel Discussion on Data Sharing**

Wednesday, November 16, 2004

Panelists: D R Sikka, V Ramanathan, Chandra Venkataranam, Sanjeeva Rao, Brent Holben, Teruyuki Nakajima, Shyam Lal and K Krishnamoorthi.

Dr D R Sikka introduced the subject explaining that the data sharing in India has been a much debated subject and a ticklish one too. Bulk of the operational meteorological data and satellite data are utilized in the domain of the major departments like IMD and the Department of Space, and there have been difficulties expressed by scientists outside these departments in acquiring data for research. This has been a major handicap. He also dwelled upon the campaign mode data acquired under the DST sponsored monsoon related field programs, which created specific data

centers and the data were freely made available to atmospheric-ocean science community within 2-years of the completion of the experiments. He mentioned that this has not been handled satisfactorily with regard to the field campaigns on Aerosol-chemistry either under INDOEX or in the IGBP-related field experiments. He stated that a large portion of the research done in India is being done by the data, which are available on internet or meteorological re-analysis projects through US, European-Japanese sources.

Professor V Ramanathan stated that the entire INDOEX data acquired under the NSF Project are available on the website of the UCAR, which is a public domain site.

Dr Chandra Venkataraman mentioned that a website was supposed to be setup for Indian INDOEX data, which did not function very satisfactorily. She expressed the view that an aerosol related data centre should be set-up in India and suggested that centers like CDAC could be involved as a facilitator for data storage and distribution. Field campaign related data have a short-use period and the best results from the data collected during the field campaigns are obtained if the data are processed and distributed within almost 2-years of the field campaigns in a systematic manner.

Dr Brent Holben shared his experience with regard to CIMEL network operated by them and mentioned about the quality control procedure for the data from this network. Data from this network is available on the internet. He stated that science programs funded in USA ensure that the data are available in the public domain within about 2-years of data collection and in this manner the data and even the products derived from such data are used by larger scientific community. He stated that it has taken time and money in evolving such procedures in USA with huge scientific benefits to larger community.

Dr Shyam Lal stated that there is a definite need for developing data-sharing capability and the ISRO's IGBP program is thinking about setting up such a facility where all the campaign-mode data acquired under the ISRO's IGBP program may reside.

Dr K Krishnamoorthi shared his experience with regard to building data facility at SPL, Trivandrum for aerosol data acquired from 3 or 4 earliest stations under ISRO's sponsorship. He mentioned that as the network has increased in recent years and is likely to be enhanced further in future, a need has been felt to establish an ISRO's IGBP-program related data.

Dr Sanjeeva Rao mentioned that the special efforts made by DST to create specialized data centers at IITM, NIO, INCOIS, NCMRWF etc, for specific field programs sponsored by DST from MONTBLEX-1990 to ARMEX-2003.

Several speakers from the house brought out suggestions about the need for Indian Aerosol research community to share these data freely. Some speakers also brought out the hesitancy of Principal Investigator in providing data to data centre as well as among other scientists. Towards the end of the session a consensus emerged on the following lines.

- Aerosol-related research would get a tremendous boost if a culture of data sharing were developed among the scientific community and the sponsoring organizations.
- Major program promoters like ISRO/DST may create special Aerosol Data Centre where it is obligatory for PI's working on their research project to finally transfer quality controlled data to this centre after about 2 years of the end of the campaigns/projects.

- Besides creating such infrastructures/facilities researchers may be encouraged to exchange data with their peers.
- Such efforts would not only enhance the utility of data acquired through public funds but also raise the prestige of organizations and individual scientists.

## **Panel Discussion on Atmospheric Science Education in Institutes of Higher Learning**

Tuesday, November 16, 2004

Panelists: Dr Vinod Tare, Dr D R Sikka, Dr Chandra Venkataraman, Dr S C Garg,  
Dr Teruyuki Nakajima, Dr Sanjay Limye

The chairman, Dr Vinod Tare introduced the theme, while stressing on the increasing role of atmospheric sciences in the study of Environment. He desired that the discussions may be focused on the theme in relation to promotion of atmospheric sciences in tackling Environmental problem and how the Institute of higher learning include this area as part of the curriculum in the teaching of engineering subjects. The panelists brought out several issues and offered suggestions, which include the following.

- Need for introduction of multidisciplinary areas like atmospheric sciences in under graduate education.
- Specialized branches of atmospheric science like geophysical fluid dynamics, mathematical modeling, earth radiation budget, climate studies and modeling like climate change, hydrology and the study of atmospheric water cycle and its modeling, atmospheric/environmental pollution, atmospheric technology, etc. may be introduced at the first year course of engineering disciplines. These courses to be given by senior faculty or senior level specialists in the area so that the young minds are ignited to the challenging problems of fundamental and applied nature of the atmospheric sciences.
- Need for holding local level summer schools on atmospheric sciences in which participation of students of under graduate colleges in the local areas are assured. The participants may get introduced to the subject and provided opportunity to mingle with the research faculties and are enabled to visit the facilities of the host Institute.
- Research facilities on atmospheric sciences may be enhanced in the engineering colleges and one or two permanent faculty members are inducted.
- Students from engineering faculties are taken on visit to major research centers on atmospheric sciences so that they are exposed to the research challenges in the area of their choice.

After a detailed discussion among the panelists and active participation of house, following recommendations were made.

- Challenges in atmospheric sciences and their role in tackling several problems in applied areas are required to be introduced early in the undergraduate engineering education.

- In latter years of the engineering courses, special topics like geophysical fluid dynamics, heat exchange, hydrology, atmospheric technology may be appropriately included under different specialized engineering disciplines. These courses could be tackled at higher level.
- Permanent faculty in the multidisciplinary area of environmental sciences and engineering may be inducted in atmospheric sciences, which could cover specialized areas and promote research in this area in the engineering faculty at large.
- Channels of exposing engineering colleges to national centers of higher research in atmospheric sciences and vice versa may be opened so that specialists at respective levels could collaborate on specific research areas effectively.

## **Poster Session**

Poster session was inaugurated on Monday, November 15, 2004 at 12:45 h by Dr Teruyuki Nakajima and was open until 15:00 h on Wednesday, November 17, 2004. Altogether 32 Posters were displayed covering several aspects of aerosol science and technology.

## **Concluding Session**

Wednesday, November 17, 2004; 16:45 – 18:00 h

Professor Ramesh P Singh, Convener, presented the summary of the deliberations of various technical sessions. Many delegates including Brent Holben, Rachel Pinker, V Sethi, P C S Devara, Sanjay Limaye, G G Pandit, Sunita Verma spoke about the success of the conference and their views on the deliberations in various technical sessions. Dr Vinod Tare, Convener, announced the awards given to the best papers and posters presented during the conference.

### Best Papers:

1. A GCM Study on Sulphate Aerosols during the Winter Monsoon Season for 1998 and 1999. Sunita Verma, S K Deb, O Boucher, H C Upadhyaya, O P Sharma, M Shekar Reddy, P Levan and F Binkowski (Technical Session II)
2. Inter-Comparison of Aerosol Parameters over Kanpur, Northern India Retrieved from Ground-Based Radiometer and Satellite Data. Sagnik Dey, S N Tripathi, A Chandel, S Srivastava and Ramesh P Singh (Technical Session VII)
3. Comparison of Performance of Sampling Devices: Moudi and Single Stage Impactor for PM<sub>2.5</sub> in Producer Gas from Thermal Biomass Gasifiers. Nitin Goyal, N Selvakumar, Pravina P Parikh and Virendra Sethi (Technical Session V)

### Best Posters:

1. Phase Function Dependence On Relative Humidity: Implications to Satellite Remote Sensing. Amit Misra and A Jayaraman
2. Estimation of percent reduction in conductivity from Ion-aerosol balance equation. K Nagaraja, B S N Prasad, N Srinivas and M S Madhava

3. Ground-based Radiometric Measurements of Aerosols and Pre-cursor Gases Over Pune and Their Comparison with TOMS and MODIS Satellite Data. R L Bhawar and P C S Devara
4. Long Term Variability in Absorbing Aerosol Loading Over India Detected by TOMS. Gazala Habib, Chandra Venkataraman, Isabelle Chiapello, S Ramachandran, Olivier Boucher, M Shekar Reddy

Awards and certificates were presented by Dr Kripa Shanker, Deputy Director, IIT Kanpur. Dr B K Sapra, Secretary, IASTA proposing the vote of thanks complimented IIT Kanpur for successfully organizing the conference.

## **Recommendations**

- Presently very few measurements are made on surface ozone levels and there is a need for more surface ozone observations in the country.
- There are several sensors e.g. NOAA AVHRR, TOMS, MODIS, which are measuring the aerosol parameters for some time, and can be easily utilized to study the spatial and temporal variations of aerosol parameters.
- Partnership with School Science-Education Programme, access to real event data (e.g. from satellites) and innovative experimental methods for attracting young minds to science are essential for progress in understanding and managing atmospheric processes.
- Application of recently developed technique to assess mixing layer height using Lidar can be extended on trial basis at suitable LIDAR sites in India.
- Empirical modeling to forecast summer rainfall using part year rainfall data may give some useful information and there is a need to strengthen such studies to predict extreme rainfall years.
- The Modis algorithm may have to be reviewed for dust loaded sites.
- Twilight photometry technique could be used to measure stratospheric aerosol optical thickness from aeronet.
- Measurements from ground monitoring stations reveal contrast in aerosol optical depths observed between a polluted urban location and a clean hill station, and more such measurements should be carried out to understand the role of pollutants in modifying the climate.
- Aerosol-related research would get a tremendous boost if a culture of data sharing were developed among the scientific community and the sponsoring organizations.
- Major program promoters like ISRO/DST may create special Aerosol Data Centre where it is obligatory for PI's working on their research project to finally transfer quality controlled data to this centre after about 2 years of the end of the campaigns/projects. Besides creating such infrastructures/facilities researchers may be encouraged to exchange data with their peers. Such efforts would not only enhance the utility of data

acquired through public funds but also raise the prestige of organizations and individual scientists.

- Challenges in atmospheric sciences and their role in tackling several problems in applied areas are required to be introduced early in the undergraduate engineering education.
- Special topics like geophysical fluid dynamics, heat exchange, hydrology, atmospheric technology may be appropriately included under different specialized engineering disciplines at senior undergraduate level. These courses could be tackled at higher level.
- Permanent faculty in the multidisciplinary area of environmental sciences and engineering may be inducted in atmospheric sciences, which could cover specialized areas and promote research in this area in the engineering faculty at large.
- Channels of exposing engineering colleges to national centers of higher research in atmospheric sciences and vice versa may be opened so that specialists at respective levels could collaborate on specific research areas effectively.