Report on Training Workshop

Remote Sensing of Atmospheric Aerosols and Their Impacts

January 2 – 16, 2011

Organized by

Research and Technology Development Centre, Sharda University, Greater Noida (India)

Conveners

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Need of the Training Workshop

In the last three decades pronounced increase in the fog, haze and smog events were observed in the northern parts of Indian during winter season and dust events during pre-monsoon season (April – June). During winter and pre-monsoon season, the life of million people living in the Indo-Gangetic basin severally get affected due to increase of atmospheric aerosols. In these two seasons, people suffer with health problems due to loading of atmospheric aerosols in the South Asian region which is due to population growth, energy demand, forest fires, industrial growth, changes in land use/land cover and anthropogenic activities. The impact of growing atmospheric aerosols are observed in general in the South Asian region, in particular to the northern parts of India where 600 million people live in the Indo-Gangetic plains which is one of the agriculturally productive regions with huge ground water resources. The increasing pollution during winter and summer season, respectively is attributed mainly due to anthropogenic activities and dust storms. During winter season, dense fog, haze and smog is formed in the northern parts of India affecting daily life of people living in the region and also affected the climate of the region. During pre-monsoon season, dusts which are originated from Thar desert and also from far western region, Arabia peninsula, hit the north-western part of the region first and enter in the Indo-Gangetic plains sometime up to the fat eastern Indian region and also sometime up to the north Himalayan region depending upon the meteorological conditions. The intense dust affect the visibility, increase the atmospheric aerosols and the meteorological conditions along the path of the dust storms. The increasing atmospheric aerosols affect the health of people living in the region and also sometime bring the scattered rainfall. In the Asian countries, the atmospheric loading increase significantly during winter and summer season and in general the life of people gets affected. The remote sensing technique has emerged as powerful tool to monitor the atmosphere and observe the areas affected by fog, haze and smog and also with the dusts and their dynamics. The satellite remote sensing data are freely available from various international and national agencies and such data can be used to study the atmospheric parameters and their influence on meteorological and cloud parameters, and also on the vegetation and climate, at local and regional scale that also provide understanding of the global changes. These data can be downloaded and with the visualization tools developed by space agencies, the dynamics of atmospheric parameters can be studied. In view of this an International training workshop **on "Remote Sensing of Atmospheric Aerosols and Their Impacts"** was organized jointly by Chapman University and Sharda University during January 2-16, 2011 at the premises of the Sharda University, Greater Noida, India. The workshop was mainly supported by COSPAR (Committee on Space Research) and co-sponsored by European Space Agency (ESA), Chapman University, USA, Department of Science and Technology, Government of India, Defence Research and Development Organization, Government of India, Council of Scientific and Industrial Research, Government of India, Ministry of Earth Sciences, Government of India and by Sharda University.

The primarily focus of the Training workshop was to give theoretical background of remote sensing and its applications to atmosphere and to provide practical training to young students and scientists so that they can handle remote sensing and ground data to study the variability, inter-annual variability and to understand trend of atmospheric and meteorological parameters at local, regional and global scale.

Lectures and Practical training:

Most of the lectures were planned in the auditorium and practical training was arranged in the Computer room where each participant was having PC and internet connection. Both the rooms were equipped with audio and video facilities.

Participants

Participants were selected by the International Advisory Committee, consists of following members

- Dr. Pierre-Philippe MATHIEU (ESA)
- Dr. Jean-Louis Fellous (COSPAR)
- Dr. Ramesh P. Singh (Chapman University)

A list of national and international participants who attended the workshop is attached in this report. The international advisory committee selected few participants from Pakistan and China, due to visa problems only one participant from China attended the workshop.

Technical Program

A detailed technical program alongwith direction to reach Sharda University was sent to each participant and speaker and also the information was uploaded on the workshop web site (http://cospar.sharda.ac.in/). Participants were provided transport from the nearest metro station to Sharda University. Speakers and international participants were provided transport from airport to Sharda University. Most of the international flights arrive late in the night or early morning. Vehicle with a volunteer was sent to international airport to receive each international participant and speakers and to bring on Sharda University campus.

Participants started arriving from January 2 and were accommodated in Heritage Hotel Club and NRI Guest House. Speakers were accommodated in Stellar Residency Gymkhana and Hotel Radisson at Noida. Local transport was arranged for participants and speakers to bring on the University campus and drop them at their hotels.

Registration

The registration of participants started at 9.00 am on Monday, January, 3, 2011 without any fees. Each participant and speaker was given a bag with a Souvenir and writing pad and pen. Each participant and speakers were given a name tag.

A wide range of topics and tools dealing with the basic principles of remote sensing, various remote sensing platforms, electromagnetic radiations, earth system science and environment, atmosphere and remote sensing applications to atmosphere and impact of the increasing atmospheric pollution on the meteorological parameters and climate were dealt by speakers in the forenoon sessions. In the afternoon sessions speakers gave tutorials dealing with the multi sensors satellite data from NASA and ESA, ground, meteorological and air quality data, various tools for data analysis. Each participant was asked to identify a small project to study atmospheric aerosols at local and regional scale and their trends. Participants made use of various tools and commonly available softwares through NASA and NOAA and use of facilities to download multi sensor data. Most of the participants showed their interest using these data and interacted with the scientists up to 7.30 pm in the evening to complete projects identified by them.

Details of day to day activities

Monday, January 3, 2011

The programme was started with registration and formal introduction. The technical programmes were discussed by the Dr. S. K. Mishra, Convener of the Workshop and Director R&D of Sharda University. Professor Ramesh Singh an Affiliate Faculty of Sharda University, Professor, School of Earth and Environmental Sciences, Chapman University, USA and Convener of the Workshop made the introductory remarks, giving background of the workshop and its goals. Professor Singh emphasised this unique opportunity to the young participants to interact closely with the national and international speakers and participants to learn how to use freely available huge volume of data and tools to study how the atmospheric aerosols in the south Asian region has changed in the last decade and their impacts on the climate and air quality. The atmospheric, meteorological and ground data will be of great importance in understanding the cause of fog, dense haze and smog formation in the Indo-Gangetic plains and other parts of the south Asian region.

The first lecture was delivered by Dr. D. R. Sikka, the former Director, Indian Institute of Tropical Metrology, Pune, India. Dr. Sikka gave an overview of development of atmospheric aerosols science in India, efforts made by Indian scientists in monitoring of aerosols. He pointed out that increasing aerosols has direct impact on the human health and also affect the monsoon in India. We have to make efforts to understand the aerosols science and its various impacts.

Prof. Ramesh P. Singh, delivered a talk on Earth System and Environment, gave an overview about the origin of the Earth and formation of lithosphere, hydrosphere and atmosphere. He pointed out that Earth is a complex system of systems and 6 billion populations on the Earth is making the Earth system more complicated. The atmospheric aerosols is increasing due to human activities and affecting the local, regional and global climate. He stated that there is urgent need to monitor atmospheric aerosols and understand the processes associated with the dynamics of aerosols to understand the cause of various impacts and to see how we can minimize its impact. Prof. Singh introduced satellite remote sensing and its importance in getting information about the globe within few hours. He gave basic principles of optical and microwave remote sensing and their applications in monitoring and retrieving various parameters of aerosols and meteorological parameters.

The evening session was held in compute room based on computer. Dr. Dimitris Kaskaoutis, visiting scientist, Sharda University explained the use of NOAA HYSPLIT tool in understanding the source of airmass reaching at any location. He gave example showing air mass back trajectories reaching over Athens, Greece. Participants interacted with Dr. Kaskaoutis and used NOAA HYSPLIT in seeing the movement of airmass reaching at their location.

Tuesday, January 4, 2011

In the first session on January 4, 2011, Prof. Ramesh P. Singh continued his lecture on basic principle of optical and microwave remote. He emphasized the role of refractive index, dielectric properties of various materials and explained how these can be used effectively to analyze the satellite and radiometer data under various conditions.

In the second session, Dr. Falguni Patadia (NASA, USA) gave talk on MISR satellite sensor. Dr. Patadia described details about the MISR instrument and the advantage of multi angle data. She showed how data can be downloaded and used for retrieval of atmospheric aerosols parameters. She discussed in detail about various algorithms for retrieval of aerosol optical depth from MISR data over land and ocean surfaces.

In the afternoon session of the workshop, Dr. Pawan Gupta (NASA, USA) gave lecture on MODIS Aerosol Products. Dr. Gupta explained the use of multi wavelength data to study the spectral properties of aerosol and to identify dust and smoke. He discussed in detail about various algorithms to identify the characteristics of smoke and dust from 36 bands data observed from MODIS satellite.

Wednesday, January 5, 2011

Dr. Pawan K. Bhartia (NASA, USA) gave a talk early in the morning session on topic, "Measurement of Aerosols from Space". He discussed the use of laboratory (ground based), field and satellite borne measurements to study the properties of atmospheric aerosol over land and ocean. He gave an overview of various techniques used by NASA in monitoring atmosphere.

In the second session, Dr. Sarath Guttikunda (Urban Emissions Information Centre, New Delhi) delivered two lectures on "Air Quality and its Monitoring". He discussed air quality and sources of pollution in Delhi region. During commonwealth games held during October 2010 he discussed how his organization in collaboration with India Meteorological Observatory and with the support from French Government. In the evening session, participants were identified small project to work and all the participants started downloading required data of their own area to work on the project.

Thursday, January 6, 2011

The morning session started with tutorials on MODIS and MISR data, all the participants interacted with Drs. Pawan Gupta and Falguni Patadia and work with the MODIS and MISR data. After the coffee break, Dr. P. K. Bhartia gave a popular lecture on "Air Quality in the Anthropocene Era – a Satellite Perspective". This lecture attracted students and faculty members of Sharda University and also people from nearby institutions. In the beginning, Prof. Ramesh P. Singh introduced invited speaker. Dr. Bhatia showed satellite images of the ozone and gave about the spatial and temporal variability over different regions and over the Antarctic region.

In the next lecture, Dr. Gerrit de Leeuw (University of Helsinki, Finland) gave lecture on the "Retrieval of Aerosol Properties over India and China using AATSR". He gave an overview of various techniques and models using ground and satellite based measurements. He stated the importance of ground measurements and models in better understanding the atmospheric processes.

In the afternoon session, Prof. John Burrows (University of Bremen, Germany) gave an overview of GOME, SCIAMACHY and MERIS satellite data in studying atmospheric constituents from basic principles of these satellites and spatial and temporal variability over the globe.

Dr. P. K. Bhartia gave a talk on the UV remote Sensing of aerosols and also tutorials dealing with UV remote sensing data for retrieving aerosols parameters. The tutorials were prepared in collaboration with Dr. Omar Torres from NASA.

Friday, January 7, 2011

In the morning session, Prof. John Burrows delivered lecture showing retrieve of Ozone, CO_2 CO, SO_2 NO_X, CH_4 and HCHO profiles using GOME, SCIAMACHY and MERIS Data. . Dr. Burrows discussed various spectral methods in order to estimate different species in atmosphere which exist in the equilibrium and influence the atmosphere, significantly.

Dr. Gerrit de Leeuw of University of Helsinki, Finland delivered another lecture on aerosol retrieval using European Satellite Data. He gave an overview of current and future missions to study the global climate changes.

Until late evening, all the participants made use of computer and worked on their projects. The session was coordinated by Dimitris Kaskaoutis, all the participants interacted with him for questions related to any problem in carrying out their project. Waseem Mehdi demonstrated how one can download AIRS data to study meteorological and atmospheric parameters.

Saturday, January 8 & Sunday, January 9, 2011

On Saturday, January 8, a trip to Agra to see the Tajmahal was planned. All the participants and speakers visited Agra in a Bus. Although Agra is about 200 km but it took long time due to dense haze and fog. They reached Agra in the evening, they get only about one and half hours to visit Tajmahal. They returned quite late after the mid night due to thick fog, the visibility was less than 20 m or so. It was unique experience of bad weather where the visibility was so poor.

On Sunday 9 January, 2011, it was free days, some of the participants visited Delhi and surrounding areas.

Monday, January 10, 2011

Prof. Gerrit de Leeuw gave his last lecture on "Current and Future European Missions for Retrieval of Atmospheric Aerosol and Monitoring of Trace Gases. He gave details of various pay loads which are used to study the atmospheric chemistry.

Dr. Thomas Wagner (Max Planck Institute, Germany) delivered a lecture on "Satellite Remote Sensing of Atmospheric Trace Gases, Aerosols and Clouds". He described in detail the importance and disadvantages of ground based and satellite observations for the aerosols and trace gases studies.

In the afternoon and evening sessions, participants continued their practical exercise looking various satellite data to study atmospheric aerosol parameters.

Tuesday, January 11, 2011

Dr. Ritesh Gautam (NASA, U.S.A) delivered a lecture on the "Impacts of Absorbing Aerosols on the South Asian Summer Monsoon and Regional Climate" using MODIS, CERES, TOMS and ISCCP data. He explained how these tiny aerosol particles affect South Asian summer monsoon. He pointed out that during winter season aerosol loading is higher due anthropogenic activities in India which are the cause of haze and fog. Using

CALIPSO and AERONET data, Dr. Gautam explained the monthly variations of aerosol parameters and observed solar radiations.

Dr. Thomas Wagner delivered his second lecture on “Satellite Remote Sensing of Atmospheric Trace gases, Aerosol and Clouds” using DOAS data and Sun Photometer (Microtops). He also gave demonstration of NO2 measurements using DOAS and some of the results of NO2 observations in Delhi.

Dr. R. K. Manchanda (TIFR, Mumbai) gave lecture on “Scientific Ballooning: Facilities and Users Support at National Balloon Facility in Hyderabad”. He described in detail the development and manufacturing of scientific balloon and its payload carrying capacity as well as the utility of balloons for vertical profiling of atmosphere with different characteristics.

In the evening, there was cultural programme (Indian Classical Dance, Odissi) arranged by the Vice Chancellor and Convener of Sharda University at the Auditorium. After the cultural program a dinner was arranged with guest, faculty members and all the participants at Stellar Gymkhana.

Wednesday, January 12, 2011

Dr. K.V. S. Badrinath a Senior Scientist from National Remote Sensing Centre, Hyderabad, India delivered a lecture on “Satellite and Ground Based Observations on Atmospheric Aerosol and Radiative Forcing – a study over Tropical Urban Region”. He presented an account of ongoing research activities in the area of remote sensing of atmospheric aerosol over the tropical urban regions. He also discusses the impact of global transport of dust and aerosol on climate, health and environment.

Dr. R. K. Jenamani a senior scientist who is responsible for providing information about day to day weather conditions at Indira Gandhi International Airport, New Delhi. His topic of lecture was “Monitoring of Weather at Delhi Airport”. He described in detail about the available facilities for daily monitoring and weather forecasting at the airport in real time for air traffic safety. He gave an account of observed fog days and duration of fog and diversion of flights to other cities in recent years.

Dr. Sanjeev Bhoi (NASA, U.S.A) delivered a talk on the "Use of Direct Broadcast Data and Technology to Process and Visualize Aerosols from MODIS satellite". He discussed the use of computer techniques to develop the model for weather prediction precisely and timely. Dr. Bhoi also discussed about the combination of Lidar and dispersive models for forecasting air quality in India.

Thursday, January 13, 2011

Dr. Nikolay P. Nezlin (SCCW Research Project U.S.A) delivered lecture on "Effect of Dust on the Ocean Colour and Ocean Productivity" followed by a computer exercise related to ocean color and dust. He described the computer technique to develop the monitoring of ocean colour using multi frequency scanning microwave radiometer data which is operating in microwave bands.

Prof. Valerio Tramutoli (University of Basilicata, Italy), delivered a talk on "Robust Satellite Techniques for Remote Sensing of Volcanic Emission". Using ground based and satellite borne data he showed how volcanic ash affected South West England after the eruption of volcano in Iceland. He also pointed out the information from FAAM research aircraft in mapping the extent and height of volcanic ash.

Dr. Khabir Uddin a participant from Jahangir Nagar University, Dhaka delivered talk on "Overview of Air pollution of Dhaka, Bangladesh and Impact of Climate Change". Prof. Ramesh P. Singh delivered a talk on the "Impact of Dust on Snow". He discussed the role of dust and black carbon on the surface of snow and ice towards melting of the Himalayan snow cover. He explained the impact of anthropogenic activities in the north parts of the India and its interaction with the Himalayan snow and glaciers. He stated that the quantitative evaluation of BC is very important in understanding of the role of BC in melting of the snow and glaciers of the Himalayan region is important to understand the hydrological resources of the Indo-Gangetic plains. Dr. L.S. Rathore (Ministry of Earth Sciences, Government of India) gave an overview of the "Agro Metrological Services in

India”. He told that farmers are getting information about the agro meteorological conditions to manage their agricultural requirements. He highlighted that currently mobile SMS services for the local weather information have been launched which is becoming popular among the farmers. He informed the role of changing climate on the productivity of crops which may be considered as another green revolution in India.

Friday, January 14, 2011

A popular lecture “Societal Benefits of Earth System Science” was given by Dr. Shailesh Nayak (Secretary, Ministry of Earth Sciences, Government of India, New Delhi). In spite of holiday in the University, lecture was attended by students, faculty members of Sharda University and other guests from adjoining institutions. He broadly mentioned about the on-going research projects in the area of agriculture, meteorology, oceanography and earth sciences taken under investigations by the Government of India. The on-going programs are weather forecasting (long-range, medium range, now casting, seasonal monsoon), Agromet advisory services, potential fishing zone advisory, weather forecast for the farmers through mobile SMS, installation of Doppler weather radar for weather forecast, forecast of fog, ocean state forecasting, Glaciological programmes in Himalaya and Antarctica etc. Prof. Ramesh Singh introduced the speaker and his contributions in the area of remote sensing particularly to ocean color field.

Prof. D. Rosenfeld (Institute of Earth Science, Israel) delivered lecture on “Floods or Droughts, how do Aerosols effect Precipitation”. He showed aircraft measurements he carried out in collaboration with Indian scientists at different locations. Dr. Freddy Pranajaya (UTIAS, Space Flight Laboratory, Canada) gave his present plan of a nano satellite mission “NEMOAM: An advanced Nano satellite for Remote Sensing of Atmospheric Aerosols”. He gave details of this mission which he is planning jointly with ISRO, India.

Prof. D.L. Tang (Chinese Academy of Sciences, China) gave a talk on the “Impacts of Atmospheric Aerosols and Typhoon on Marine Phytoplankton”. She showed that during

Sumatra tsunami and in number of typhoon events how the chlorophyll concentrations increased at various coastal regions.

Prof. Valerio Tramutoli gave an interesting lecture on “Robust Satellite Techniques for Remote Sensing of Sand Storms”.

Dr. Sachchidanand Singh (National Physical Laboratory, New Delhi) delivered his lecture on “Aerosol Radioactive Forcing Scope and Challenges in the Indian Perspective”.

Saturday, January 15, 2011

Dr. D. Rosenfeld delivered a talk on “From expanding Marine Stratocumulus to Weakening Hurricanes, Aerosol Cloud Mediated Climate Effects” in different regions. He discussed airborne and satellite data from different regions.

After coffee break, Valedictory Function was arranged. Prof. Ramesh P. Singh presented summary of lectures and tutorials sessions and also about the brief projects carried out by participants. Prof. Singh also informed about the fellowships sponsored by COSPAR Capacity Building panel to take benefit of this program. Dr. D. R. Sikka (former Director, IITM, Pune, India) gave his remarks and future opportunities and benefit of working in the field of atmospheric aerosols. Some of the participants gave their feedback stating how they enjoyed this workshop in learning new topics and tools. All the participants they provided their feedback about the scientific sessions and logistics of the workshop.

Dr. Ravi P. Singh (Vice Chancellor, Sharda University) addressed the participants, delegates and speakers. He extended his thanks to all the sponsoring agencies and to the people who were behind the successful organization of the workshop.

Dr. D. R. Sikka gave diploma certificate received from COSPAR to each participant. At the end, Dr. S. K. Mishra (Convener) extended vote of thanks to the participants, speakers, funding agencies and to all other who contributed in the organization of this two weeks workshop.

Sunday, January 16, 2011

Participants were picked from their hotels and dropped to airports and railway stations as per their schedule.

Technical Programme of the Workshop

Monday, January 3, 2011	
0930 – 1000	**Registration and Introduction**
1000 – 1100	**D. R. Sikka** (**Sharda University, Greater Noida)** – Overview on Atmospheric Aerosols, why study of Atmospheric Aerosols is important?
1100 – 1130	**COFFEE BREAK**
1130 – 1300	**Ramesh P. Singh (Chapman University, USA)** – Earth System and Atmosphere
1300 – 1430	**LUNCH**
1430 – 1545	**Ramesh P. Singh (Chapman University, USA**) – Basic Principles of Remote Sensing
1545 – 1610	**COFFEE BREAK**
1610 – 1730	**Pawan Gupta (NASA, USA)** – MODIS Satellite and Data Products
1730 – 1845	**Dimitris Kaskaoutis** (Sharda University, Greater Noida) Computer Exercise (Use of HYSPLIT air mass back trajectories for the aerosol monitoring: Application over Athens)
Tuesday, January 4, 2011	
0930 – 1045	**Ramesh P. Singh (Chapman University, USA)** – Optical and Microwave Ren Sensing
1045 – 1115	**COFFEE BREAK**
1115 – 1300	**Falguni Patadia (NASA, USA)** – MISR Satellite and Aerosol Products
1300 – 1430	**LUNCH**
1430 – 1545	**Pawan Gupta (NASA, USA)** – Tutorials on MODIS Aerosol Product
1545 – 1615	**COFFEE BREAK**
1615 – 1800	**Computer Exercise (Practice)**

Wednesday, January 5, 2011	
0930 – 1045	**Pawan K. Bhartia (NASA, USA)** – Aerosol Measurement from Space
1045 – 1115	**COFFEE BREAK**
1115 – 1230	**Sarath Guttikunda (Urban Emissions Info, New Delhi)** – Air Quality and Monitoring
1230 – 1300	**Discussion**
1300 – 1430	**LUNCH**
1430 –1545	**Sarath Guttikunda (Urban Emissions Info, New Delhi)** – Monitoring of Air Quality during Commonwealth Game and Air Quality Modeling
1545 – 1615	**COFFEE BREAK**
1615 – 1800	**Pawan Gupta/ Falguni Patadia (NASA, USA)** – MODIS/MISR Data Processing
Thursday, January 6, 2011	
0930 – 1045	**Pawan Gupta/Falguni Patadia (NASA, USA) –** MODIS/MISR Aerosol Data Products (tutorials)
1045 – 1100	**COFFEE BREAK**
1100–1200	**Pawan K. Bhartia (NASA, USA) – Popular lecture, entitled "Air Quality In the"Anthropocene" Era- a Satellite Perspective" (University Auditorium)**
1200–1300	**Gerrit de Leeuw (University of Helsinki, Finland)** – Retrieval of Aerosol Properties over India and China using AATSR
1300 – 1430	**LUNCH**
1430 – 1500	**John Burrows (University of Bremen, Germany)** – Remote Sensing using GOME and SCIAMACHY and MERIS
1500 – 1615	**Pawan. K. Bhartia/Omar Torres (NASA, USA)** – UV Remote Sensing of Aerosols
1615 – 1630	**COFFEE BREAK**
1630 – 1800	**Pawan K. Bhartia (NASA, USA)** – Computer tutorials, Aerosol measurements from space

Friday, January 7, 2011	
0930 – 1045	**John Burrows (University of Bremen, Germany**) – Remote Sensing using GOME, SCIAMACHY and MERIS
1045 – 1115	**COFFEE BREAK**
1115 – 1230	**Gerrit de Leeuw (University of Helsinki, Finland)** – Current Status of Aerosol Retrieval using European Satellite Data
1230 – 1300	**Waseem Mehdi (Sharda University, Greater Noida) -** AIRS data Computer Exercise
1300 – 1430	**LUNCH**
1430 – 1545	**Waseem Mehdi, (Sharda University, Greater Noida**) AIRS data Computer Exercise
1545 – 1615	**COFFEE BREAK**
1615–1715	**Dimitris Kaskaoutis (Sharda University,Greater Noida)** – Using of the Curvature in the AOD for Classification of Major Aerosol Types over Different Environments over the Globe
1715 – 1800	**Waseem Mehdi (Sharda University, Greater Noida)** Computer practice
Saturday, January 08, 2011	
8000 – 2200	**Agra Visit**
Sunday, January 9, 2011, Free Day	
Monday, January 10, 2011	
0930 – 1015	**Gerrit de Leeuw (University of Helsinki, Finland)** –Current and Future European Missions
1015 – 1100	**Thomas Wagner (Max Planck Institute, Germany)** – Satellite Remote Sensing of Atmospheric Trace Gases, Aerosols and Clouds
1100–1115	**COFFEE BREAK**
1115 – 1200	**Ravi Manchanda (TIFR, Mumbai)** Studying Aerosol: New Pathways
1200 – 1300	**Manish Sharma and Waseem Mehdi (Sharda University, Greater Noida)** Pyranometer, Microtops, Aethalometer **–** observations and data analysis
1300 – 1430	**LUNCH**
1430 – 1545	**Waseem Mehdi and Dimitris Kaskaoutis (Sharda University, Greater Noida)** Computer Exercise
1545 – 1615	**COFFEE BREAK**
1615 – 1800	**Waseem Mehdi (Sharda University, Greater Noida)** Meteorological data using Russian website Computer Exercise

Tuesday, January 11, 2011	
0930 – 1030	**Ritesh Gautam (NASA, USA)** – Impacts of Absorbing Aerosols on the South Asian Summer Monsoon and Regional Climate
1030 – 1045	**COFFEE BREAK**
1045 – 1130	**Ravi Manchanda (TIFR, Mumbai)** Scientific Ballooning: Facilities and Users Support at NBF Hyderabad
1130– 1300	**Thomas Wagner (Max Planck Institute, Germany)** –Satellite Remote Sensing of Atmospheric Trace Gases, Aerosols and Clouds
1300 – 1430	**LUNCH**
1430 – 1545	**Sanjeeb Bhoi (NASA, USA)** – Use of Direct Broadcast Data and Technology to Process and Visualize Aerosol from MODIS
1545 – 1615	**COFFEE BREAK**
1615 – 1800	**Thomas Wagner (Max Planck Institute, Germany)** – NO_2 measurements using DOAS (Tutorial)
1800	**Odissi Dance at Auditorium**
Wednesday, January 12, 2011	
0930–1015	**K. V. S. Badrinath (National Remote Sensing Centre, Hyderabad) -**Satellite and ground based observations on atmospheric aerosols and radiative forcing – A study over tropical urban region
1015-1100	**Devendra Singh (DST, New Delhi) –** Application of Remote Sensing for Atmospheric Aerosols Monitoring and their Impact on Climate
1100 – 1115	**COFFEE BREAK**
1115 – 1200	**R. K. Jenamani (IGI Airport, New Delhi)** – Monitoring of Weather at Delhi Airport
1200 – 1300	**R. K. Jenamani (IGI Airport, New Delhi**) – Fog Characteristics
1300 – 1430	**LUNCH**
1430 – 1545	**Nikolay P. Nezlin (SCCW Research Project, USA**) – Ocean Color as a Method Assessment of Phytoplankton Biomass and Productivity
1545 – 1615	**COFFEE BREAK**
1615–1715	**Sanjeeb Bhoi (NASA, USA)** – Computer Demonstration
1715-1900	**Project Presentation (Participants)**
Thursday, January 13, 2011	
0930 – 1030	**Nikolay P. Nezlin (SCCW Research Project, USA)** – Computer exercise related to Ocean Colour and Dust
1030 – 1130	**Project Presentation (Participants)**
1130 – 1145	**COFFEE BREAK**

1145 – 1200	**Khabir Uddin (Jahangirnagar University, Dhaka) --** An Overview of Air Pollution of Dhaka, Bangladesh and Impacts of Climate Change on Bangladesh a Some Initiatives
1200 – 1300	**Ramesh P. Singh (Chapman University, USA)** – Impact of Dust on Snow
1300 – 1430	**LUNCH**
1430 – 1530	**L. S. Rathore (MoES, IMD New Delhi) –** Agro-meteorological Services in India
1530 – 1615	**Nikolay P. Nezlin (SCCW Research Project, USA)** – Effect of Dust on the Ocean Colour and Ocean Productivity
1615 – 1630	**COFFEE BREAK**
1630 – 1900	**Valerio Tramutoli (University of Basilicata, Italy)** – Robust SatelliteTechniques for Remote Sensing of Volcanic Emissions
Friday, January 14, 2011	
0930 – 1015	**Freddy Pranajaya (UTIAS Space Flight Laboratory, Canada)** NEMO-AM: An Advanced Nano-satellite for Remote Sensing of Atmospheric Aerosols
10.30 – 1130	**Shailesh Nayak (Secretary, MOES) Popular lecture on "**Societal Benefits of Earth System Science"
1145 – 1300	**D. Rosenfeld (Institute of Earth Science, Israel)** – Floods or Droughts: How do Aerosols Affect Precipitation
1300 – 1400	**LUNCH**
1400–1500	**D. L. Tang (Chinese Academy of Sciences, China) –** Impacts of Atmospheric Aerosols and Typhoon on Marine Phytoplankton
1500–1600	**Valerio Tramutoli (University of Basilicata, Italy**) – Robust Satellite Techniques for Remote Sensing of Sandstorms
1600 – 1615	**COFFEE BREAK**
1615 –1715	**Sachchidanand Singh (National Physical Laboratory, New Delhi)–** Aerosol Radiative Forcing: Scope and Challenges in the Indian Perspective
1715 – 1815	Discussion
Saturday, January 15, 2011	
0930 – 1030	**D. Rosenfeld (Institute of Earth Science, Israel)** – From Expanding Marine Stratocumulus to Weakening Hurricanes: Aerosol Cloud-Mediated Climate Effect
1030 – 1045	**COFFEE BREAK**
1045– 1145	**Valedictory**
1230 – 1400	**LUNCH**

International Participants

Jiujuan Wang	South China Sea Institute of Oceanology, Chinese Academy of Sciences
Md. Khabir Uddin	Department of Environmental Sciences, Jahangirnagar University Dhaka
Md. Mamul Islam	Rajshahi University, Bangladesh
Nahid Rizwan	University of Dhaka, Bangladesh

National Participants

Anupriya Singh	UPTU
Bineta Pathak	Dibrugarh University
Puna Ram	Tata Institute of Fundamental Hyderabad
Deepti Sharma	Punjab University Patiyala
K. Nagaraja	Banglore University (Assistant Professor Phy Dept)
Jyotsna Singh	SRF, Department of applied maths, BIT MISRA, Ranchi
Krishna Kumar	Truvananthpuram University Kerla
Lipi Kumari	BIT Mesra, Ranchi-835215
Neyyala Lokeshwara Rao	Indian Institute of Remote Sensing(IIRS)
Mahesh.R	Annamalai University, Tamil Nadu.
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Akshansha Chauhan	Sharda University, Greater Noida
Manish Sharma	Sharda University, Greater Noida
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Dr. Sanjeeb Bhoi (NASA, USA)

Prof. John Burrows (Germany)

Dr. Ritesh Gautam (NASA, USA)

Dr. Pawan Gupta (NASA, USA)

Dr. Dimitris Kaskaoutis (Greece)

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Dr. F. Patadia (NASA, USA)

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Prof. Ramesh P. Singh (USA)

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Dr. Thomas Wagner (Germany)

Indian Speakers

Prof. Madhoolika Agarwal

Dr. K. V. Badarinath

Dr. Sarath Guttikunda

Dr. R. K. Jenamnai

Dr. Ravi Manchanda

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Dr. L. S. Rathore

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Photo Gallery


Remote Sensing of Atmospheric
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Evolution of the earth's atmosphere


Multi-angle Imaging SpectroRadiometer
MISR
Remote Sensing of Atmospheric Aerosols and Their Impacts


MERIS / BAER (Bremen


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Remote Sensing of Atmospheric Aerosols and Their


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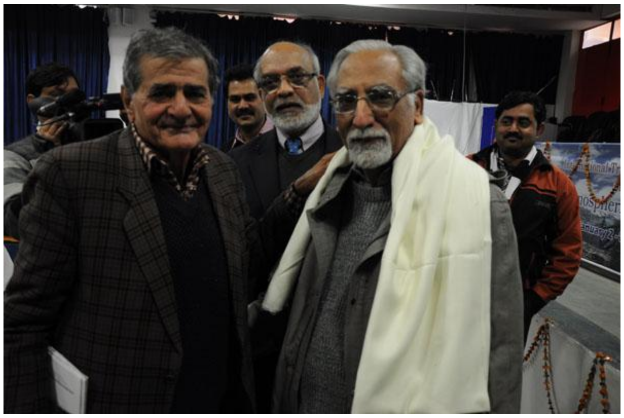
Seasonal variations

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SHARDA
UNIVERSITY
Beyond Boundaries


Mid-Project Review held on 13 Jan 2011 at ISRO Satellite Application Centre


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Beyond Boundaries
Remote Sensing of Atmospheric Aerosols
January 2-16, 2011


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January 2-16, 2011
11.01.2011 05:58


International Training Workshop
on
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11.01.2011 05:35


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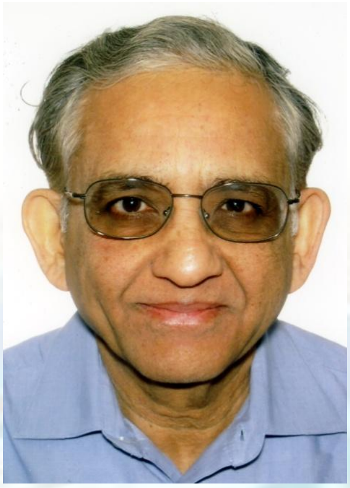
Popular Lecture

on

Air Quality in the "Anthropocene" Era- a Satellite Perspective



Pawan K Bhartia

Senior Research Scientist

Laboratory for Atmospheres

NASA Goddard Space Flight Center, Greenbelt, Maryland

Chemistry Nobel Laureate Paul Crutzen has coined the term "anthropocene" to put the modern industrial era in the geological context to highlight the fact that human-induced changes to the earth are in some cases as large as the changes that occurred in geological times. Though the changes in the terra firma and the biosphere are the most visible manifestations of these changes, the quality of our life-sustaining atmosphere is also changing rapidly. Air quality is affected not only by the "bad air" that we can smell or feel in our lungs but also by the rate of change in the composition of the "good air" that has made life on this planet possible. The composition of the good air has been changing too rapidly recently for the life to adapt to it. The most well known of these changes has been the rapid thinning of the ozone layer in the polar regions, popularly known as the Ozone Hole. Satellite images of this phenomenon captured the attention of the world in the mid 80s leading to rapid phase-out of the offending chemicals. I will illustrate what constitutes good and bad air using images derived from modern satellite instruments and discuss why it is necessary to combine data from remote sensing and in-situ instruments with numerical models to understand this complex phenomenon

6 January, 2011 at 11:00 AM

Auditorium

Sharda University, Greater Noida

SHARDA UNIVERSITY

Popular Lecture

on

Societal Benefits of Earth System Science

Dr. Shailesh Nayak

Secretary, Ministry of Earth Sciences

Government of India

New Delhi

14 January, 2011 at 10:30 AM

Auditorium

Sharda University, Greater Noida

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Project Reports

Submitted

by

Participants

Aerosol Optical Thickness from satellite derived data for Bangalore (12.9 N, 77.5 E), India

Nagaraja Kamsali
Department of Physics, Bangalore University, Bangalore – 560 056 India
Email: kamsalinagaraj@bub.ernet.in

Abstract

The quality of the aerosol optical thickness (AOT) data retrieved operationally from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensors aboard the Terra and Aqua satellites from 2008 to 2009 were evaluated thoroughly for a continental station Bangalore (12.9 N, 77.5 E), India. The area-averaged time series of Aerosol optical depth from Terra/Aqua for the duration of two years from January 2008 to December 2009 for the region 75E-80E and 10N-15N is observed and analysed. It is found that AOTs were maxima in July. Monthly variations show mean value of 0.40 and 0.56 for Terra, and 0.46 and 0.41 for Aqua in 2008 and 2009, respectively. Monthly variation of Aerosol optical depth for different wavelengths from MISER shows a mean of 0.34, 0.27, 0.22 and 0.17 for 443, 555, 670 and 865 nm, respectively. Maximum AOT is observed for the shorter wavelength than for the longer wavelengths. Higher concentrations were observed during summer and monsoon seasons compared to winter and post-monsoon seasons. The results obtained here show contradiction to the usually expected behaviour of decrease in AOT due to washout because of precipitation. The reason being that, even though the reduction in AOTs exist in monsoon, the transportation of aerosols from other areas and local activities such as vehicular traffic, emissions from industries will lead to enhancement of AOTs. This work was carried out at COSPAR-2011 at Sharda University, Greater Noida, India during workshop and the preliminary results were presented.

Introduction:

Atmospheric aerosol is a major concern for climate prediction and public health, but records of global aerosol distributions have only become available in the last decade from dedicated satellite observations such as MODerate resolution Imaging Spectro-radiometer (MODIS) (Remer et al., 2008) and the Multiangle Imaging SpectroRadiometer (MISR) (Kahn et al., 2005). Despite much progress made recently in using satellite data to derive surface aerosol concentration over land, several challenges exist. The radiance or reflectance data collected by currently operational passive remote sensing instruments for aerosol retrieval are mostly at the atmospheric window channels in the visible spectrum. Therefore, they offer little information on aerosol vertical distribution beyond the retrieval of columnar properties such as aerosol optical thickness (AOT) (Wang et al., 2003). In the near UV spectrum, the slope of the reflectance is regulated by height-dependent Rayleigh scattering and aerosol absorption, and this relationship can be used to estimate the centroid height of absorbing aerosols (Torres et al., 2007). However, such an algorithm requires a priori information on aerosol single scattering albedo to infer AOT, and it lacks sensitivity to changes in lower tropospheric aerosol mass. With very few observational constraints on aerosol vertical distribution, studies to date have had to use chemistry transport models to interpret the 2D satellite information of either AOT or reflectance into the 3D aerosol fields (Wang & Christopher, 2003). A common practice so far has been that the simulated aerosol mass at each vertical layer in a model grid box is updated by a scale factor that is the ratio of spatiotemporally-collocated AOT values from the model and the satellite retrieval algorithm (Wang et al., 2004; Liu et al., 2007; van Donkelaar et al., 2010). Resultant surface aerosol concentrations generally show better agreement with ground-based counterparts than those obtained without applying the scale factor, highlighting the value of the satellite AOT for the remote sensing of air quality.

In south Asia, the atmospheric aerosols have increased significantly in the last three decades due to population growth, energy demand, forest fires, industrial growth, changes in land use/land cover and anthropogenic activities. The effect of increasing atmospheric loading is being felt by people living in the region directly and indirectly locally and also globally. The NASA image shows a pale band of haze covers northern

India, just south of the Himalayas in the image, taken Feb. 5, 2006, by NASA's Aqua satellite. Haze also intrudes into the skies of southern Nepal and Bangladesh. The recent studies have shown that the pollution in the northern parts of India affects the day to day life of million people living in India and adjoining regions in general and in particular the life of people living in the Indo-Gangetic plains. The increasing pollution has found to affect the hydrological cycle, agricultural productivity, climate and weather conditions and also the snow cover and glaciers of the Himalayan region. In this regard, an effort is made to study the influence of AOT on the atmosphere and on clouds.

In this paper, focus will be mainly on a comprehensive evaluation of Terra and Aqua MODIS spectral aerosol optical thickness, which is the most important parameter from which others can be derived. Another major aspect of this study is to use the opportunity afforded by the availability of aerosol data from Terra and Aqua to study the patterns of aerosol distribution in the morning and afternoon. One has to think of why are these aerosols important? And the reasons are as follows: aerosols scatter and absorb sunlight, and thus can cool or warm the surface and atmosphere leading to the estimation of energy budget, as nucleation centers, aerosols can change the drop size distribution within clouds, affecting cloud reflectance and lifetime, thereby controlling the microphysics of clouds, fine particles penetrate lung tissue and affect respiratory function lead to several health problems, even high altitude aerosol plumes affect aircraft which has aviation hazards, also it acts as an index of air pollution, forecasting of weather, dynamics of the earth’s atmosphere.

Methodology:

The Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on board the Terra and Aqua platforms provide nearly daily global coverage of key atmospheric and land surface parameters. Retrievals of aerosol optical depth (AOD) by MODIS are 25 the most commonly used of any satellite AOD product. Although MODIS is technically a research instrument, its use in operational applications is increasingly widespread. The MODIS Collection 5 aerosol product (Levy et al., 2007) at 10×10 km^2 resolution from the Terra and Aqua satellites over the continental station, Bangalore (12.9 N, 77.5 E), India from January 2008 to December 2009 were used for the analysis. Terra and Aqua, which are both polar-orbiting satellites, cross the equator during the daytime at approximately 1030 (morning) and 1330 (afternoon) local time (LT), respectively. Radiance data are acquired by MODIS in 36 spectral bands, spanning 405–14,385 nm wavelengths, which range from the visible (VIS) through the near-infrared (NIR) and midinfrared (MIR) up to the thermal infrared (TIR) regions of the electromagnetic spectrum. They are acquired in one of three spatial resolutions at nadir: 0.25 km (bands 1–2: VIS), 0.5 km (bands 3–7: VIS-MIR), and 1 km (bands 8–36: VIS-TIR). MODIS data are being used operationally to generate a variety of geophysical parameters employed in monitoring the Earth's lands, oceans, and atmosphere.

The aerosol index (AI) is obtained from the OMI measures the upwelling radiance in the 270–500 nm bands. It has near daily global coverage with a 2600 km swath width and a spatial resolution of 13x24 km^2 at nadir and 28 x 150 km^2 near the edge. The AI is derived from the difference between the wavelength dependence (354 and 388 nm) of reflected radiation in an atmosphere containing aerosols and a pure molecular atmosphere from Rayleigh scattering. In the UV, absorbing aerosols such as dust and smoke often produce positive AI values.

Results and Discussions:

The role of aerosol effects on climate has gained renewed attention in the last decade since they change the radiation balance of the earth-atmosphere system by reflecting and absorbing solar radiation, modifying cloud properties and reducing the amount of solar radiation reaching the ground (Intergovernmental Panel on Climate Change, 2007). The spatial and vertical distribution of aerosols and their absorptive and reflective properties also influence atmospheric circulation patterns, cloud formation and hydrological processes. Therefore, monitoring the spatial distribution of aerosols and their properties is critical for climate research, and for validating the performance of dust models in higher-resolution mesoscale models. Although several hundred Aerosol Robotic Network (AERONET) measurements are available around the world that routinely provide aerosol optical thickness data (Holben et al., 2001), satellite remote sensing provides far more complete global coverage. The MISR has four spectral channels (446, 558, 672, and 867 nm) with a spatial resolution of about 250 m to 1.1 km with nine cameras that enable aerosol retrievals globally without any limitations caused by surface type (Kahn et al., 2005).

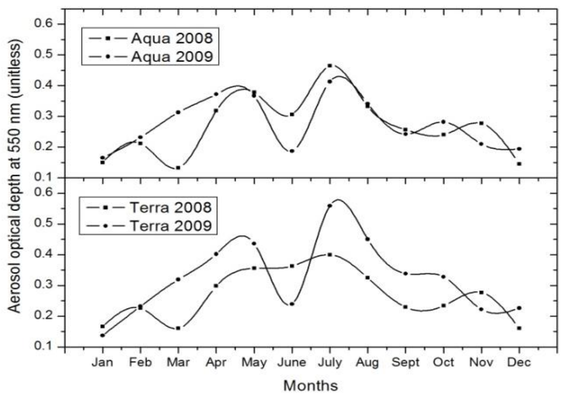

Fig. 1: Area-averaged time series of Aerosol optical depth at 550 nm from MOD/MYD for the duration of two years from January 2008 to December 2009 for the region 75E-80E and 10N-15N.

Figure 1 shows the area-averaged time series of Aerosol optical depth at 550 nm from Terra/Aqua for the duration of two years from January 2008 to December 2009 for the region 75E-80E and 10N-15N. One can observe the maxima in AOTs in July for both the years and all the profiles show similar trend. The values show an increasing trend from January to July and then decrease till the end of the year, December. Monthly variations show mean value of 0.40 and 0.56 for Terra, and 0.46 and 0.41 for Aqua in 2008 and 2009, respectively. The standard deviation does not exceed 0.1 in all the cases. Singh et al. (2004) have also observed the pronounced seasonal variations.

Monthly variation of Aerosol optical depth for different wavelengths from MISER for the period from January to December 2008 for the region 75E-80E and 10N-15N is shown in Figure 2. The AOT varies from 0.24 to 0.46 with a mean of 0.34 for the wavelength 443 nm in blue region, varies from 0.19 to 0.37 with a mean of 0.27 for the wavelength 555 nm in green region, varies from 0.16 to 0.31 with a mean of 0.22 for the wavelength 670 nm in red region and varies from 0.12 to 0.25 with a mean of 0.17 for the wavelength 865 nm in infrared region. Maximum AOT is observed for the shorter wavelength than for the longer wavelengths. In addition, an increase of 22% of AOT is observed for the change in wavelength from blue to green and red to infrared, while a change of 18% observed for the wavelength shift from green to red.

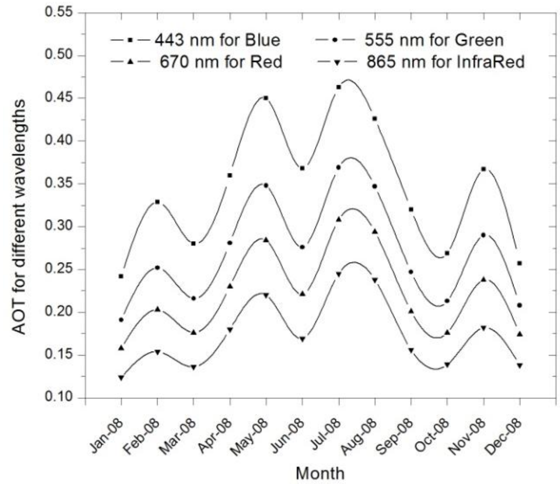

Fig. 2: Monthly variation of Aerosol optical depth for different wavelengths from MISER for the period from January 2008 to December 2008 for the region 75E-80E and 10N-15N.

The Fig. 3 depicts the seasonal variation of Aerosol optical depth at 550 nm from MOD/MYD for the duration of two years from January 2008 to December 2009 for the region 75E-80E and 10N-15N. The seasons were classified according the standard convention of India Meteorological Department (IMD), Government of India and is considered as winter during January and February, summer from March through May, Monsoon from June through September and post-monsoon falls from October to December. Higher concentrations were observed during summer and monsoon seasons compared to winter and post-monsoon seasons. The results obtained here show contradiction to the usually expected behaviour of decrease in AOT due to washout because of precipitation. The reason being that, even though the reduction in AOTs exist in monsoon, the transportation of aerosols from other areas and local activities such as vehicular traffic, emissions from industries will lead to enhancement of AOTs and this is confirmed by Vinoj et al. (2004). To get clear picture of transport of parcel of air, the trajectories will help in arriving the solution to this problem. In view of this, air mass trajectories from HYPSPLIT during different months covering entire year during 2009 for the location Bangalore at 77.5E and 12.9N are obtained and plotted in Figure 4. It shows that the wind is coming from northern-west northern part of land to the studied area during winter, from Arabian ocean during summer, from Indian ocean and Bay of Bengal during monsoon and from Bay of Bengal during post monsoon seasons.

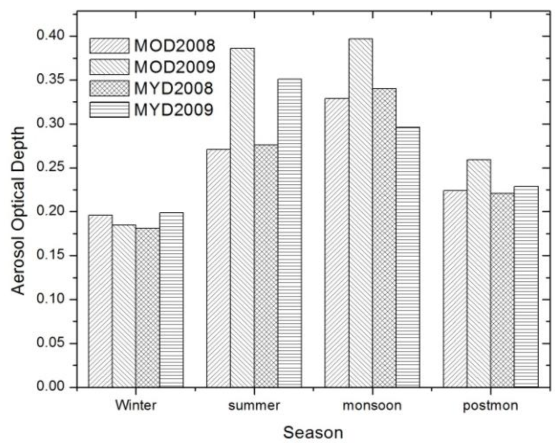

Fig. 3: Seasonal variation of Aerosol optical depth at 550 nm from MOD/MYD for the duration of two years from January 2008 to December 2009 for the region 75E-80E and 10N-15N.

Kaskoutis et al. (2009) observed the mean composite vector wind at 925-mbar level over the Indian region for all seasons. In the winter, the winds over the Indian subcontinent are generally low, exhibiting larger speeds over the oceanic areas. The wind flows mainly from eastern/northeastern directions, carrying significant amounts of polluted air masses over the Arabian Sea (AS) in certain cases. Fair weather conditions with clear skies exist during winter with continental air masses passing over the region. Low-level inversions in the morning and evening hours, and haze in the morning occur during this period along with the incursion of dry polar continental air in the wake of low-pressure systems. In general, during premonsoon season (March–May), the weather over and around India is very hot with a daily maximum temperature around 40 ^{o}C, while the surface winds are mostly gusty, especially over northern AS, northern Indian Ocean (NIO) and Bay of Bengal (BoB). The dust content over northwestern India (Thar Desert) is at its maximum and often dust exposures affect, while cumulonimbus clouds develop around late afternoon to evening hours. Development of low-pressure systems due to increased heating over land start in premonsoon, when all India has the same pressure distribution, with only slightly higher pressure over the AS and the BoB. The Indian summer monsoon (June–September) is a part of a large-scale circulation pattern, which develops in response to the thermal gradients between the warm Asian continent in the north and cooler NIO in the south. A strong southwesterly flow in the lower troposphere brings a substantial supply of moisture into India, which is released as precipitation almost across the entire country. In this period, the most strong and gusty winds occur all over the region. Monsoon and aerosol loading in the atmosphere are very intricately related to each other because of the amount and type of the aerosols, which act as cloud condensation nuclei (CCN), together with the available moisture in the atmosphere that determines the amount of rainfall occurring over the region. In the postmonsoon period (October–November 2007) a low-pressure system was developed over South India resulting in moderate winds from northeastern directions over AS and continental India, and in a persistent western flow over NIO.

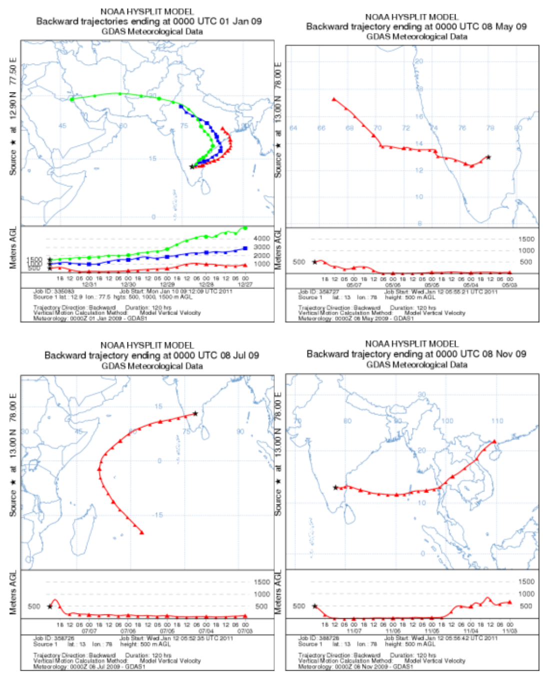

Fig. 4: Air mass trajectories from HYPSPLIT during different months covering entire year during 2009 for the location Bangalore at 77.5E and 12.9N.

Vinoj et al. (2004) observed large AOT variations in contrast with the summer monsoon over Bangalore. They reported that, in monsoon season, rainfall is widespread and consequently the entire region is depleted in aerosol loading. This is in contrast to isolated rains where the wash out is only local and will be replenished soon by transport of aerosols (mostly sub micron in size and are long-lived) from nearby regions, which are not affected by rain. However, during monsoon, aerosols over a very large area are affected and hence AOD remains low for three to four months. Sub micron aerosols (which are several orders of magnitude larger in number compared to super micron aerosols) are mostly affected by rain (and hence the AODs at shorter visible wavelengths). Thus if there is a local rainfall deficiency, there will be a large increase in the AODs at shorter visible wavelengths. The super micron aerosols (which influence the AODs at near IR wavelengths) are more localized and short-lived. The regional meteorology of southern Asia is dominated by the Asian monsoon circulation is discussed in detail by Lawrence and Lelieveld (2010). The monsoon meteorology can be broken down into three basic periods: the summer or southwest (SW) monsoon, the winter or northeast (NE) monsoon, and the Monsoon Transition Periods (MTP). The torrential rains of the Asian summer monsoon are well known, for example, Cherrapunji in eastern India receives almost 12m of rain per year. Every summer, steady onshore winds bring air from the ocean over the continent, which has been heated by the tropical overhead sun. The moist, hot air in the surface layer rises, due to buoyancy as well as orographic forcing over features such as the Western Ghats Mountains at the Indian coast. The rising air cools, causing water to condense, forming cloud droplets and heating the air masses due to the enthalpy (latent heating) of condensation, which reinforces the buoyant rising motion. This results in moist, deep convection, in which the air parcels can ascend several km in the cores of cumulus convective towers, often reaching and sometimes even penetrating the tropopause. The lofted air then spreads out, forming massive cirrus anvil clouds which can be clearly seen as a major feature of the region in satellite images. Deep convection can build up to virtually explosive energies, with updraft speeds in this region often exceeding 1 m/s, and sometimes exceeding 10 m/s, and can transport largely intact air parcels from the surface to the Upper Troposphere (UT) in less than an hour. Once the air reaches the UT, it typically encounters much faster winds than those which are found near the surface. During the summer monsoon, the most frequent intense convection is found in the ITCZ, where air masses from the northern and southern meteorological hemispheres converge. Throughout most of the world the ITCZ is located within a few degrees of the equator. Over Asia in summer, in contrast, it is generally located between 5N and 30N, directly over many of the highly populated and polluted regions of southern Asia. During the winter, the ITCZ migrates south with the solar heating, and is typically found between about 5S and 15S. The wintertime winds over much of southern Asia are generally from the NE to the SW, with some exceptions, especially the easterlies over central India, and the northwesterlies near the Himalayas. This period is known by various terms, including the “northeast monsoon”, the “winter monsoon”, or alternatively the “dry season”. There is little rain or deep convection over southern Finally, during the MTP (around May and September), the ITCZ moves tens of degrees to the north or south over a period of several weeks, the meridional monsoon winds weaken, and strong zonal winds transport emissions from Africa and southeast Asia over the central Indian Ocean.

Variation of UV Absorbing Aerosol Index from OMI aerosol index for the duration of two years from January 2008 to December 2009 for the region 75E-80E and 10N-15N is plotted in Figure 5. Aerosol index shows huge fluctuations with continuous variability and has an increasing trend from the beginning to end of the year. Correlation coefficient of linearity with the regression of 0.129 and 0.294 is observed for 2008 and 2009. It is evident that an increase in aerosol index is due to enhancement of vehicular activity, industrialization and anthropogenic activities in urban cities like Bangalore. The AI values can also be inverted to produce UV AOT values that are highly dependent on assumptions in aerosol height leading to an overall uncertainty of about 30% in the retrieved AOT. Moreover the AI is not sensitive to boundary layer aerosols below 1–2 km and subpixel cloud contamination also poses problems (Torres et al., 2005).

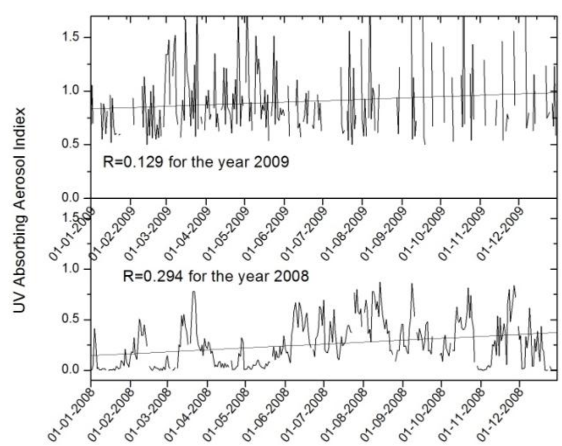

Fig.5: Variation of UV Absorbing Aerosol Index from OMI aerosol index for the duration of two years from January 2008 to December 2009 for the region 75E-80E and 10N-15N.

The Fig. 6 represents the spectral distribution of Aerosol optical depth at 550 nm for the 24-months from January 2008 to December 2009 for 5 by 5 degree covering peninsular India. The spectrum shows a variability of 0.1 to 0.26 for both Terra and Aqua observations. Over the city one can see the values are predominant in the range 0.1 to 0.18. Compared to the rainfall distribution during 2008 and 2009, the AOTs are more during monsoon period compare to the other seasons. Continuous data for long-term is required in addition to the ground based measurements to serve better tools for the analysis and use them as supportive information.

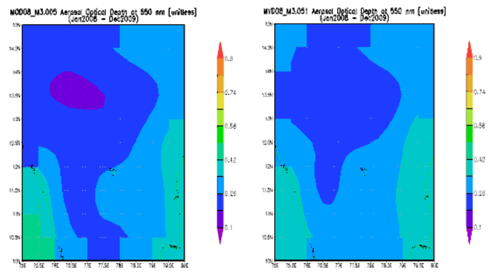

Fig. 6: Spectral distribution of Aerosol optical depth at 550 nm for the 24-months from January 2008 to December 2009 for 5 by 5 degree covering peninsular India.

Acknowledgments:

The aerosol optical depth data is obtained from MODIS and MISR that are available at Atmospheric Sciences Data Center at NASA Langley. Also, the back trajectories for the station are obtained from HYSPLIT and I am thankful to the scientific community maintaining the data. The author is highly thankful to the COSPAR-2011 for selecting me for the participation in the workshop and to Sharda University, Greater Noida, India for providing all computational facility.

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Spatial distribution and Vertical Structure of the MABL Aerosols over Bay of Bengal during winter: Results from W_ICARB Experiment

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Abstract

The first ever in-situ measurements of size-segregated vertical profiles of aerosol in the marine atmospheric boundary layer (MABL) over the Bay of Bengal (BoB) are presented in this study. The aerosol vertical profiles, made at five different locations during the winter Integrated Campaign of Aerosols, gases and Radiation Budget (W_ICARB). The altitude variation of aerosol number density is found to be steady at all locations within the convective boundary layer [up to ~ 400 m], while above it the aerosol concentration is found to decrease, except at far east BoB. The effective radius (R_{eff}) is larger in northeastern BoB, while the number concentration of the coarse-mode aerosols shows a decrease with altitude. Examination of the simultaneous air-mass back trajectories along with the aerosol size distribution indicates that the aerosols advected from continental India have a strong natural (coarse mode) component, while those originating from east Asia are, in general, of accumulation [anthropogenic] mode. The general consistency between MABL and columnar aerosol characteristics indicates that the majority of the aerosols are within the lower troposphere; however at specific locations there is also possibility for distinct aerosol layer above.

1. Introduction

Characterization of the physical, chemical and optical properties of aerosols, along with their spatial and temporal variations, has received significant attention because of their important role in the atmospheric radiation budget and climate change [e.g. IPCC 2007]. As such, the monitoring of the atmospheric aerosols and their spatio-temporal heterogeneities (caused by the distributed nature of their sources and sinks, long-range transport at different altitudes and the mesoscale and synoptic scale atmospheric dynamics) over the Indian sub-continent and adjoining oceans is of great importance in assessing the aerosol radiative impact and its regional climate implications. Aerosols in the marine atmospheric boundary layer (MABL) are mainly composed of sea salt and naturally produced sulfates [Blanchard and Cipriano 1987; O'Dowd and Smith 1993]. Despite numerous investigations on aerosols from ground and space over the globe, the information on the size-segregated vertical profiles of aerosols has been reported for few locations [Clarke et al., 1996; de Reus et al., 2001; Maletto et al., 2003; McKendry at el., 2004] and there exist no such measurements over the oceans adjoining Indian peninsula. However, such information is very critical for impact assessment of aerosols, particularly when different aerosol types co-exist in the vertical column leading to structures in the altitude profile of the size distribution [e.g. Satheesh et al., 2008].

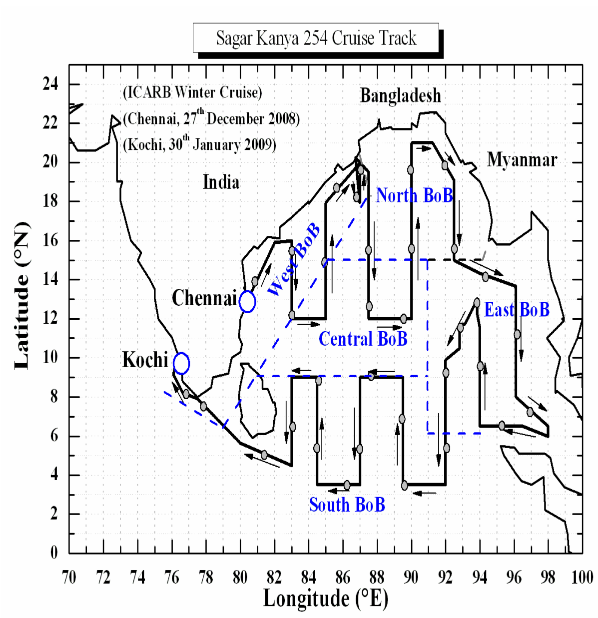
The outflow of aerosols and pollutants from the densely populated and industrialized Indo-Gangetic Plains (IGP) over BoB, mainly driven by the northeastern monsoon in winter, results in significant loading of natural and anthropogenic aerosols in the northern BoB [Girolamo et al., 2004]. On the other hand, it was found that air masses coming from southeast Asia affect most the eastern BoB with significant load of anthropogenic aerosols. Being downwind of these two major aerosol source regions (IGP and southeast Asia), the northern and eastern BoB experience high concentrations of fine-mode aerosols from continental anthropogenic sources.

2. Experimental Set-up and Observation Details

The W_ICARB, spanning from 27 Dec 2008 to 30 Jan 2009, aimed at measuring aerosol properties over the BoB during the winter season. The vertical profiling of the number size distributions was made at 5 regions over the BoB and EAS, which are considered to be distinctively different.

Size-segregated aerosol number concentrations were measured at all locations in 15 size bins in the diameter range 0.3-20 μm using the OPC (GRIMM 1.108, http://www.grimm-aerosol.com). The ambient air is aspirated into the unit via an internal volume-controlled pump at a rate of 1.2 lpm and it performs self-test and zero calibration check at the beginning of each measurement. During each ascent, the OPC was tied to the payload strings of the tethered balloon, along with a GPS to obtain the true height of the sampling level. We used 9 m^3 aerodynamically shape hydrogen filled tethered balloon (kytoon, Fig. 2), Payload was released with the help of a winch and measurements were taken at regular altitude intervals of 50 meters with sampling rate of 6sec.

a)



b)

Fig.1. a) The cruise track of Sagar Kanya 254, b) Photograph showing the hoisting of the Kytoon on board the ship. OPC is seen tied to the belly strings

3. Results and Discussion

3.1. Spatial and diurnal variation of aerosol number density

The spatial variation of total aerosol number concentration ($N_{T)}$ at the surface level over the entire BoB is shown in Fig.2 as obtained from the regular monitoring of the OPC onboard the ship [excluding the periods of profiling]. Very high concentration (> 500 cm^{-3}, going as high as 700 cm^{-3}) occurred over a comparatively small region in the northwestern extreme BoB (generally called head BoB) along the coastal Indian land mass. The large N_T values are generally associated with high AOD_{550} and vice-versa (Fig.2b) which indicates that the majority of the aerosols are within the MABL over Bay of Bengal (BoB) [Sinha et al.submited manuscript]

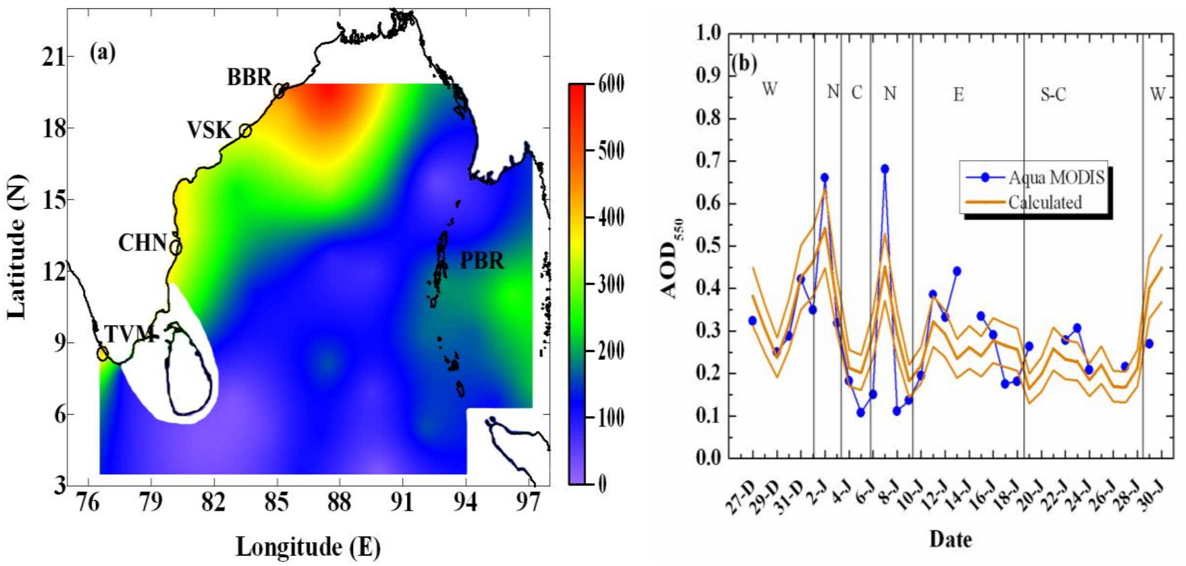


Fig.2. a) Spatial distribution of total aerosol number concentration [cm^{-3}], b) Spatial distribution of the AOD_{550} derived by Aqua –MODIS. The main coastal urban centers are depicted in the figures: (Trivandrum, TVM; Cheni, CHN; Visakhapatm, VSK; Bubhaneswar, BBR; Port BlaEntire, PBR) and W, N, S-C and E correspond to the position of the ship in west, north, south-central and east BoB, respectively.

3.2 Vertical profiles of Aerosol Number Density in the MABL

The vertical profiles using the Kytoon were obtained over four regions over BoB (1 to 4 in Fig.1a) and one profile over southeastern Arabian Sea (west off TVM, 5 in Fig.1a). The profiles are shown in the extreme left panels of Fig. 3 (a to e) separately for accumulation-mode aerosols (N_{ACC} [cm^{-3}] diameter < 1 μm) and for coarse-mode aerosols (N_{COA} [cm^{-3}], diameter >1 μm). Almost all the profiles, excluding the one at the central BoB, show that the accumulation-mode concentration remains nearly steady with altitude up to ~ 400 m, above which the variation is location specific. The altitude variations of coarse-mode aerosols are much similar to those of the accumulation mode at the respective locations. However, the concentrations of coarse-mode aerosols are far lower than those of the accumulation-mode particles by a factor of 50 to 500; the difference being highest in the northern BoB (~500) and least in the northeastern BoB (~50). Except from the profiles over central (a) and eastern (d) BoB where the N_{COA} shows an increasing trend with altitude above 400 m, the N_{COA} generally reduces for larger altitudes may be from gravitational deposition of the larger aerosols. Examining the aerosol vertical profiles along with those of the thermodynamic parameters (middle panels), it emerges that a convectively well-mixed atmospheric layer, extended up to ~ 500 m, occurs in all the cases [Sinha et al., 2010].

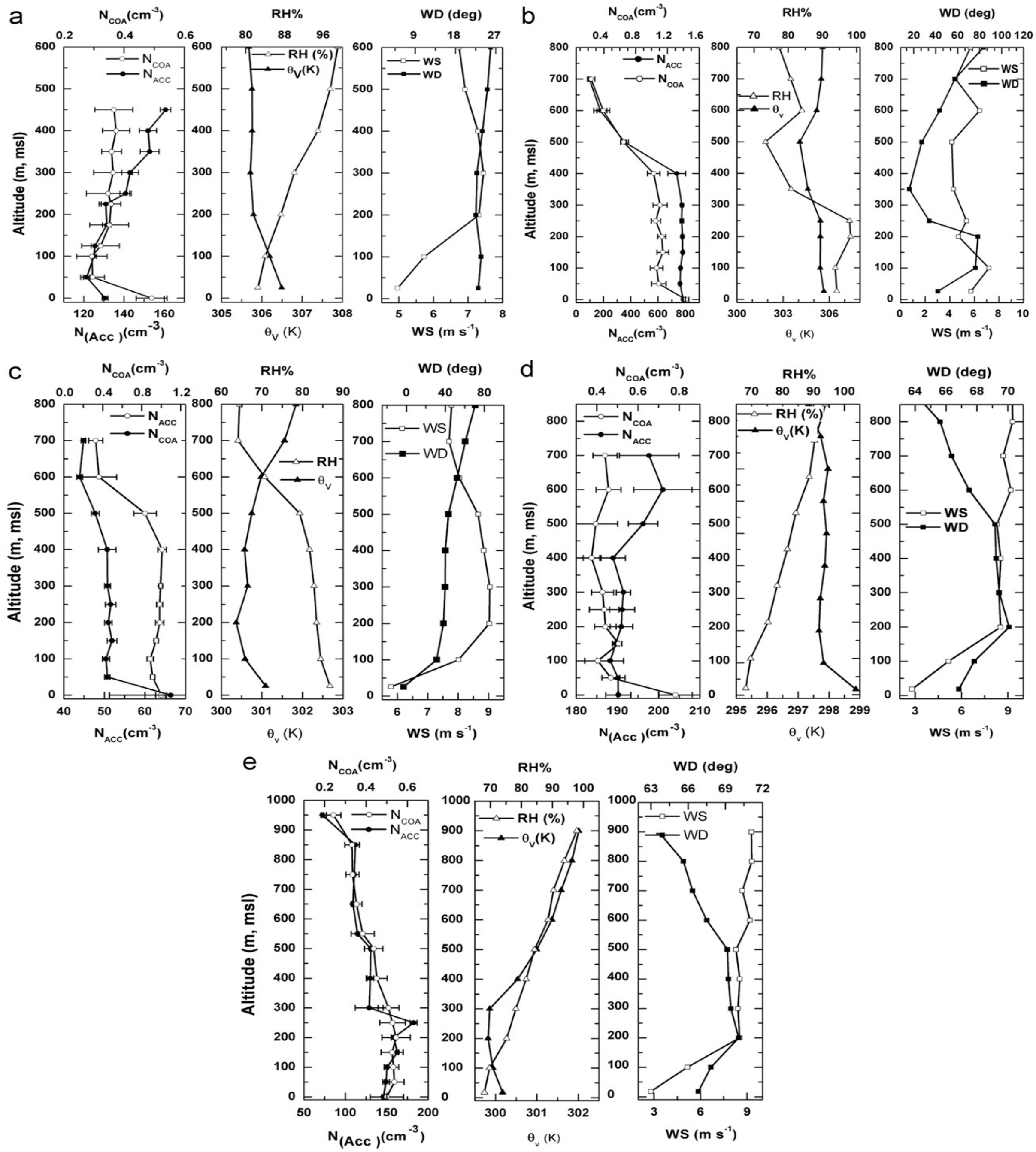


Fig. 3. Left panels show the altitude variation of number density of accumulation mode particles and coarse mode aerosols, the middle panel shows the altitude variation of virtual potential temperature and relative humidity and the right panels depict the variations of wind speed (WS) and direction (WD) over distinct regions over the BoB and Arabian sea; (a) Central BoB (region1); (b) head BoB (region 2); (c) north-eastern BoB (region 3); (d) eastern BoB (region 4), east of Andaman islands and (e) Arabian sea close to the southwest tip of peninsular India (region 5).

3.3 Aerosol Size distribution and Derived parameters

The aerosol size distribution is a key parameter for aerosol climate forcing and also useful to discriminate the origin and type of the aerosols [Eck et al., 2005]. Te size distributions were parameterized using a combination of a power-law distribution in the sub-micron regime followed by a secondary lognormal distribution in the super-micron range of the form:

$$n(r) = N_{01} r^{-\nu} + \frac{N_{02}}{\sqrt{2\pi}\sigma_2 r} \exp\left[-\frac{(\ln r - \ln r_{m2})^2}{2\sigma_2^2} \right]$$

while N_{ACC} and N_{COA} depend on the aerosol abundance, R_{eff}, ν, r_{mi} and σ_i basically depend mainly on the size distribution. These parameters are shown in Fig. 4.

It is interesting to note that r_{m2} and R_{eff} remain rather steady within the MABL at each location; however their values differ from location to location. Northeastern BoB exhibits the highest R_{eff}, mainly because of the very large depletion in accumulation mode (sub-micron) aerosol concentration over this region. On the other hand, the analysis poses serious concern on the suitability of near surface measurements for the climate impact assessment of aerosols especially when significant amount of aerosols are present above the surface.

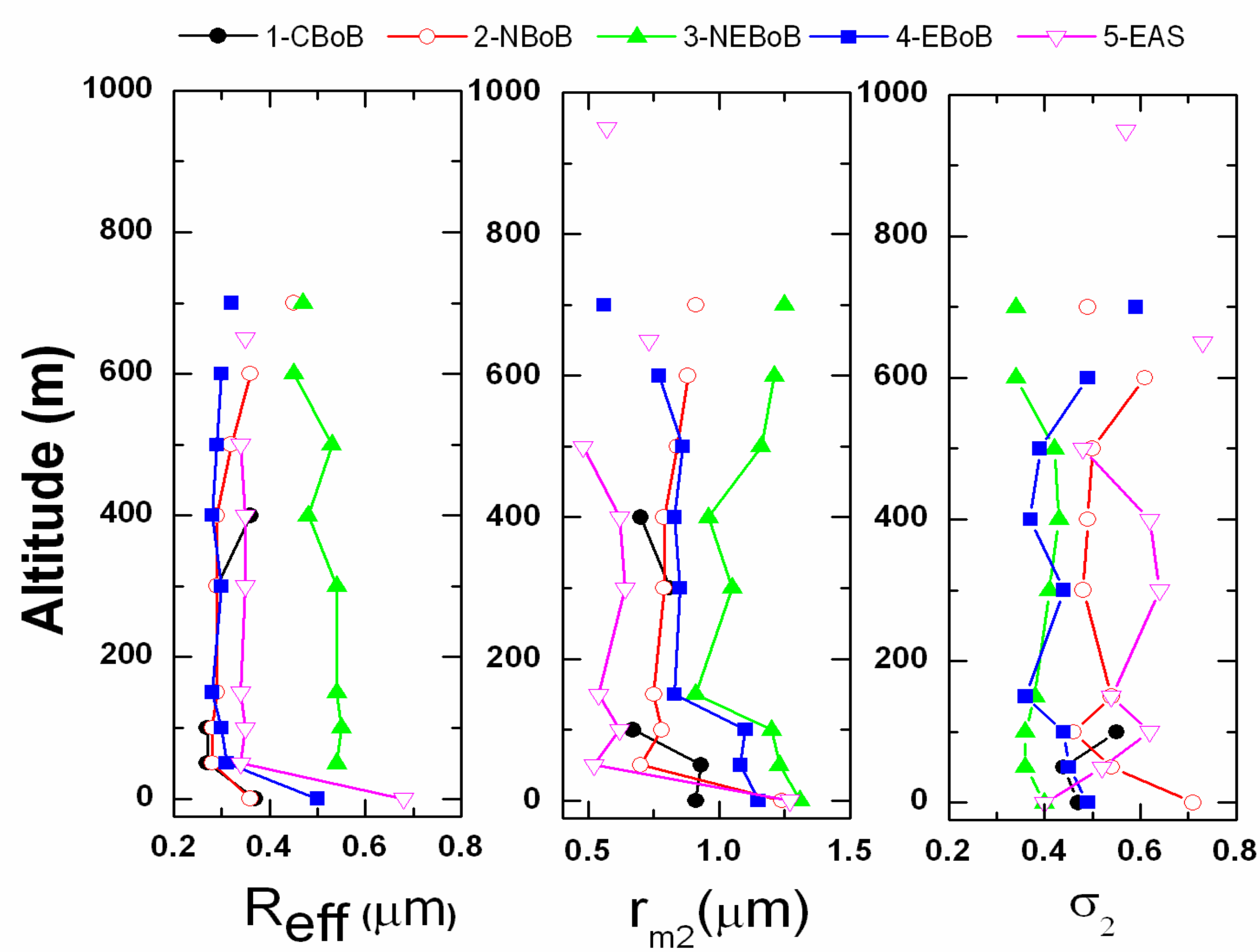


Fig.4. Altitude distribution of effective radius (R_{eff}), mode radius (r_{m2}) and standard deviation (σ_2).

4. Air Mass Trajectory Analysis

Five-day isentropic air-mass backward trajectory analysis using HYSPLIT model [Draxler and Rolph 2003] indicated that the air masses reaching over central and northern BoB (regions 1 and 2), mainly originated from the IGP, while those reaching over northeast, east BoB (regions 3 and 4) and over coastal Arabian Sea (region 5) were originating from the East Asian regions. The air masses from continental India carry mainly anthropogenic aerosols from densely populated regions mixed with natural aerosols on some occasions. On the other hand, the air masses originated from southeast Asia carry anthropogenic aerosols over BoB as well as biomass burning from extensive forest fires, while it was found that the eastern BoB is being most affected by these air masses.

5. Summary and conclusion

The first ever in-situ measurements of size-segregated vertical profiles of aerosol in the marine atmospheric boundary layer (MABL) over the Bay of Bengal (BoB), made at five different locations during the winter Integrated Campaign of Aerosols, gases and Radiation Budget (W_ICARB) showed

1. The large spatial variability in aerosol properties over BoB with high aerosol concentration over northern BoB (> 500 cm^{-3})and low aerosol concentration (≤100 cm^{-3}) over southern BoB with a moderate aerosol concentration (250 to 450 cm^{-3}) over far east BoB.

2. The altitude variation of aerosol number density is found to be steady in the convective boundary layer (up to ~ 400 m) at all locations over BoB and above that the aerosol concentration is found to decrease, except at far eastern BoB. Over far eastern BoB, the altitude distribution of aerosol number concentration showed an increase at ~ 600 m.

3. The simultaneous air mass back trajectories computed at respective locations indicated that the air masses reaching over central and northern BoB, mainly originated from the Indo-Gangetic Plains, while those reaching over eastern/far eastern BoB and coastal Arabian Sea were originating from the East Asian regions. This along with the observations of effective radius (R_{eff}) and mode radius of the size distribution (r_{m2}), indicated that while the aerosols advected from IGP had an important natural (coarse mode) component, those from the east-Asia region were, in general, of accumulation mode.

Acknowledgements

The authors gratefully acknowledge the ISRO-GBP program office, the W_ICARB team, Officers and crew of the ORV Sagar Kanya and staff members of National Balloon Facility (TIFR), Hyderabad for the onboard facilities and support. We acknowledge NOAA Air Resources Laboratory for providing the HYSPLIT transport and dispersion model (http://www.arl.noaa.gov/]and modis science time (http://g0dup05u.ecs.sa.gov/ Giovanni/)

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COSPAR PROJECT

Submitted by: Deepti Sharma

Punjabi University

Patiala (Punjab)

Study of AOD using satellite remote sensing and its comparison with ground based measurements

Objectives:

Objective 1: Retrieval of AOD using MODIS and MISR

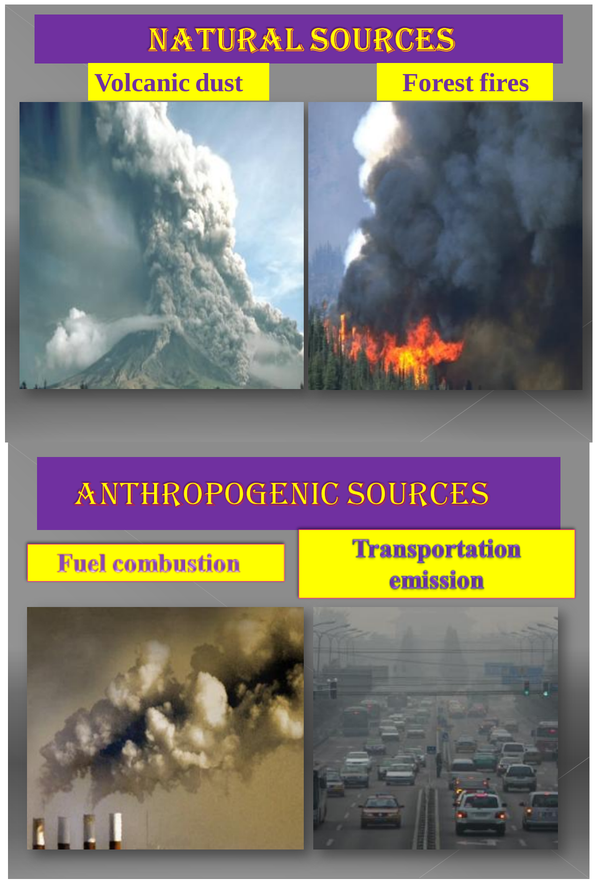
Objective 2: Comparison of retrieved AOD with AOD using MICROTOPS

INTRODUCTION

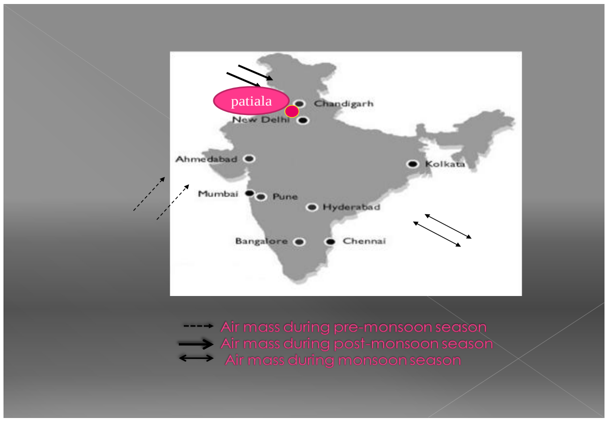
Aerosols play a crucial role in atmospheric physics and chemistry and hence wield a significant influence on weather and climate. Atmospheric aerosols are the solid and liquid particles suspended in the air. These aerosols are produced by natural processes as well as by anthropogenic activities. Usually aerosols in the atmosphere vary over a size ranging from few nanometers to several tens of micrometers and are classified into three categories viz.

I. Nucleation mode or Aitken mode (radius varies in the range 0.001-0.1 µm approx.)
II. Accumulation mode (radius varies in the range 0.1-1.0 µm approx.)
III. Coarse mode (radius › 1.0 µm)

The smallest aerosols belonging to nucleation mode are mostly produced by gas-to-particle conversion processes occurring in the atmosphere. Aerosols belonging to accumulation mode are usually produced either by coagulation (a process in which two or more aerosols combine together to form a single larger aerosol) of smaller particles or by heterogeneous condensation of gas vapor onto existing smaller nucleation mode particles. Coarse mode particles are produced by mechanical processes. The sources of aerosols are both natural and anthropogenic. Natural sources of aerosols include their production due to chemical reactions taking place in the atmosphere, arid and semi-arid regions windblown soil dust, smoke from burning of land biota etc. The anthropogenic sources include the emission of soot, smoke and dust etc. from transportation, industrial emission, biomass and bio-fuel burning etc.



Our sampling site Patiala (30.2^{o} N, 76.2^{0} E, 249 m a.s.l); located in Indo-Gangetic plain, is close to Shivalik Hills in the east and Thar Desert in the southwest and is being crowded by industrial and polluted cities like Ludhiana in northwest and Ambala in the east. The climate of the city is very hot in the summer and very cold in the winter.



Brief introduction about MODIS and MISR:

- **MODIS:**

  The MODIS (Moderate Resolution Imaging Spectrometer) instrument is operating on both the Terra and Aqua spacecraft. It has a viewing swath width of 2,330 km and views the entire surface of the Earth every one to two days. Its detectors measure 36 spectral bands between 0.405 and 14.385 µm, and it acquires data at three spatial resolutions -- 250m, 500m, and 1,000m. It covers 1354 x 2030 km area in 5 min.

- **MISR :**

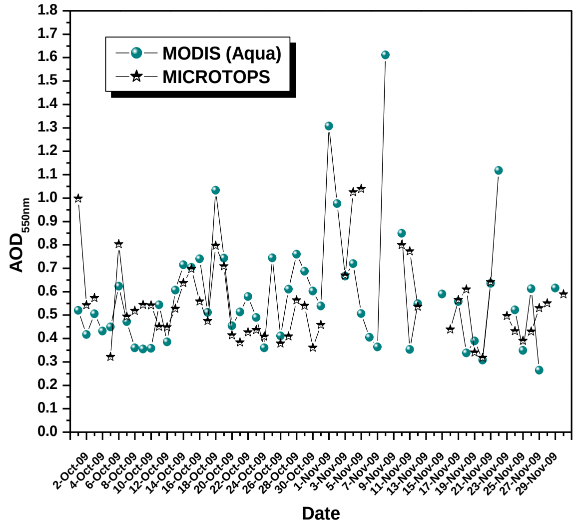
  The Multi-angle Imaging Spectroradiometer (MISR) was successfully launched into sun-synchronous polar orbit aboard Terra, NASA's first Earth Observing System (EOS) spacecraft which makes measurements at 9 cameras four forward, four backward and one nadir. It has a swath of 360km and covers the entire earth in 8-9 days.

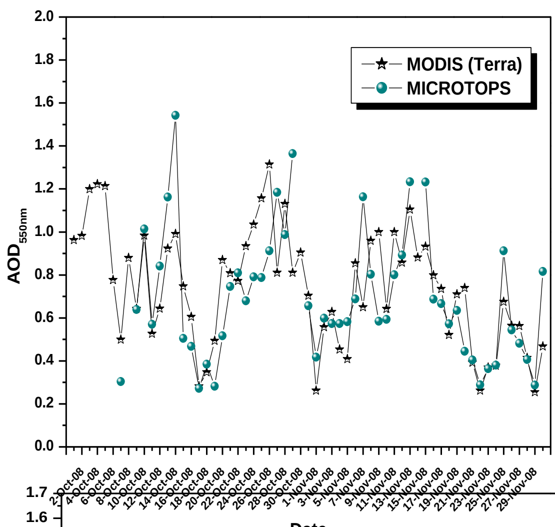
Results:

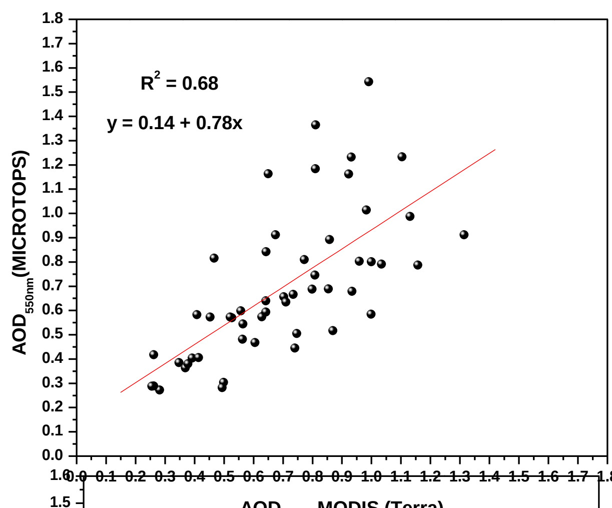
- Comparison of AOD550nm using MODIS (Terra) and MICROTOPS for Agriculture burning season for the year 2008 and 2009:

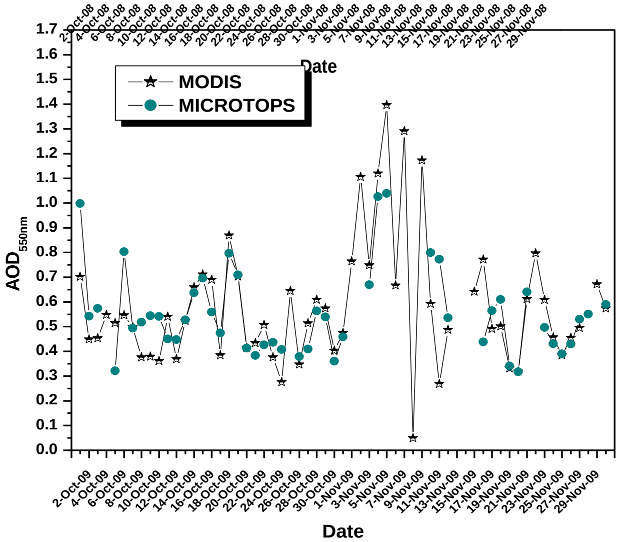
In the figure AOD is high during the months of October and November because of burning of paddy residue in the fields during these months which eject a large amount of fine mode particles in the atmosphere.

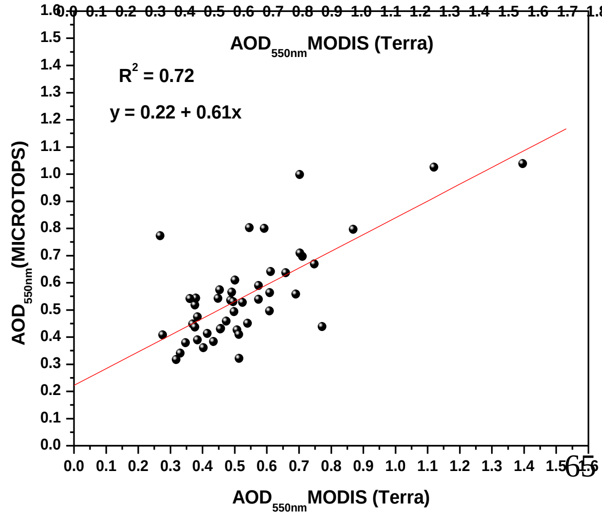
Comparison of AOD550nm using MODIS (Aqua) and MICROTOPS for Agriculture burning season for the year 2009:

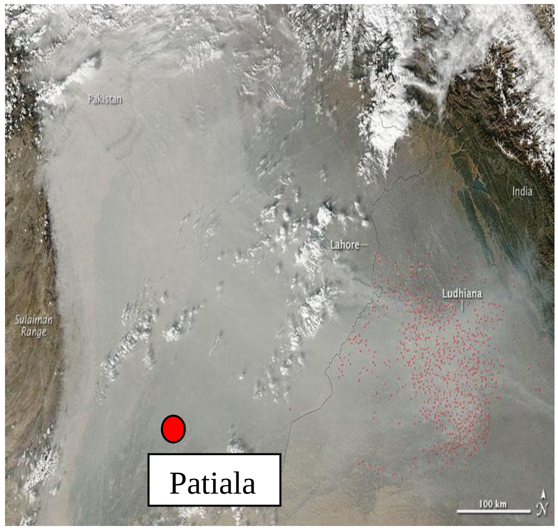






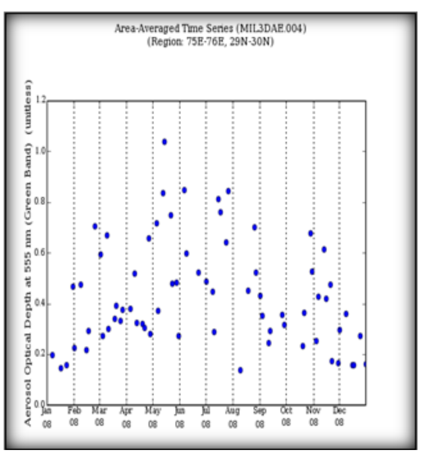


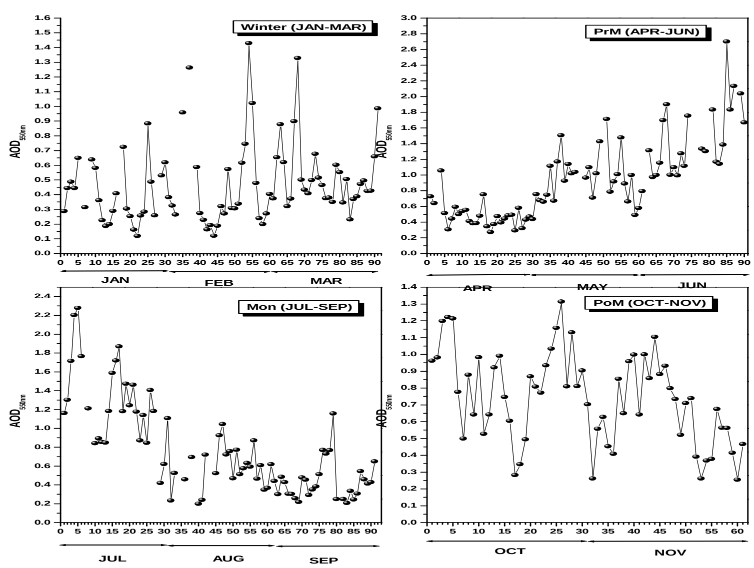




This picture of smoke is taken by MODIS (Aqua) on 09-11-2009, it may be due to the biomass burning events in Punjab which inject fine mode particles into the atmosphere and hence lead to high AOD as is shown in as is highlighted in the figure.

- Annual & Seasonal variation of AOD550nm using MISR and MODIS (Terra) for the year 2008:





In pre-monsoon season southerly winds carry dust particles from Thar Desert leading which enhances the concentration of coarse mode particles in the atmosphere which in turn increases AOD. On the other hand AOD is high during post-monsoon season due to the burning of paddy residue in the fields which elevate the concentration of submicron black carbon aerosols in the atmosphere. Though spectral AOD is minimum during winter season but its spectral variations are similar to that during post-monsoon season indicating that same type of aerosols still persist but with diminishing concentration.

Acknowledgement:

I am thankful to COSPAR and the convener of this workshop for giving us this platform to learn about Remote Sensing. I am thankful to NASA website for providing the data of various satellites and to all the speakers for all the hard work and efforts they put for teaching us. I am thankful to Sharda university faculty and M. Tech students for their time to time help.

Long Term Trend in Solar Radiation and Atmosphere

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1. Introduction

The basic source of energy for all processes on earth is solar radiation. Its availability over the earth surface is a function of latitude, seasons, time and transparency of the atmosphere (Sarkar, 2007). Atmospheric transmissivity depends on atmospheric conditions such as aerosol extinction cloud amount, cloud optical thickness, absorption by water vapor and other gases (Matsuda, 2006). Aerosol have role in the Earth's radiation budget by their scattering and absorption properties and indirectly it acts as a cloud condensation nuclei (Charlson et al., 1992). And because of this transmissivity of atmosphere varies a lot and overall trend of solar radiation shown some skeptical results and we observed the era of global dimming (Stanhill and Cohen 2001). As global warming or dimming is a global phenomenon and to have a better and realistic study of these aspects we need a global coverage which is hardly possible by in situ observation. So these satellite observations are the only source for getting information on global scale.

In this study satellite data are used for analyzing the trend of net shortwave radiation, aerosol optical depth (AOD) and cloud fraction for Nagpur, India. Here we also tried to compare aerosol properties for two year 2008-2009. Finally tropospheric NO_2 was studied for the same period.

2. Study Area and Datasets

For the present work Nagpur (21°08'N, 79°10'E) is selected, the climate of Nagpur is tropical wet and dry. To see the trend of net shortwave radiation, aerosol optical depth, cloud fraction and tropospheric NO_2 satellite observation data has been used which are downloaded from Giovanni website (http://disc.sci.gsfc.nasa.gov/giovanni). There are many instances of Giovanni. Parameters, instances and data period are given as follows- Net shortwave radiation (GLDAS monthly-Noah Model) (1979-2009), AOD and Cloud fraction (MODIS and MISR monthly) (2001-2009), Tropospheric NO_2 (Aura OMI L3) (2008-2009).

3. Methodology

Annual mean of net shortwave radiation from 1979-2009 was analysed to see the trend. Like this annual mean of the AOD at 550 nm and cloud fraction at spatial resolution (1^o x 1^o) derived from TERRA and AQUA satellites are used for trend analysis for the year 2001-2009. AOD at 555nm from MISR data with spatial resolution (0.5^o x 0.5^o) is also studied for 2001-2009. Two years 2008-2009 are compared, where monthly AOD, cloud fraction and NO_2 are analysed.

4. Results and Discussions

4.1 Long Term Trend in net shortwave radiation

The trend of net shortwave radiation from (1979-2009) is shown in Figure 1. From 1979-1999 not much change was observed but after 1999 there was sudden increase in net shortwave radiation and in 2001 one peak was observed second peak in 2009 so after 1999 we have increasing trend for short wave radiation.

4.2 AOD and Cloud Fraction

Annual average of AOD and Cloud fraction are analysed from 2001 -2009 from MODIS TERRA which has not shown a very clear trend. But after removing very high and low value slight increasing trend in AOD and for cloud fraction, we observed decreasing trend. When TERRA and AQUA data are compared then we got R^2 =0.7 (Figure-3). Monthly mean values of AOD and cloud fraction for 2008 -2009 are shown in Figure 2. Higher values of AOD and cloud fraction have been observed for 2008 from MODIS TERRA. But with MISR it has shown higher values for year 2009. If we have high AOD and cloud fraction then net shortwave radiation must be low. So we summed the values of

Net short wave radiation for the whole year and for 2008 total net shortwave radiation was 2519 W/m^2 compare to 2600 W/m^2 in 2009. This indicates that MODIS data tracked the AOD and cloud fraction variation more correctly than MISR.

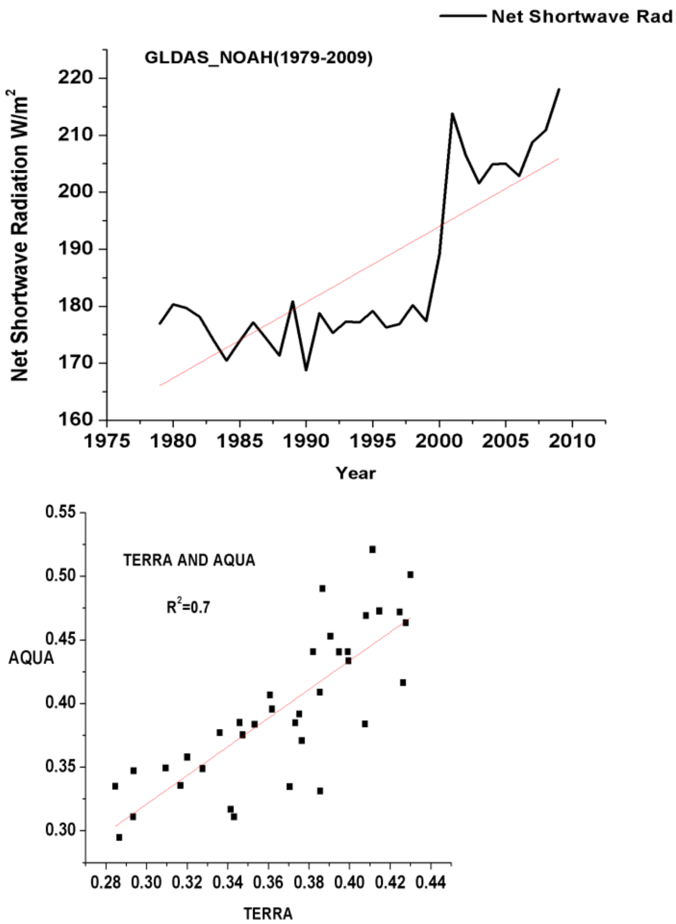

Figure 1. Long term trend of net short wave radiation for Nagpur for the period 1979-2009 and R^2 for TERRA and AQUA Data

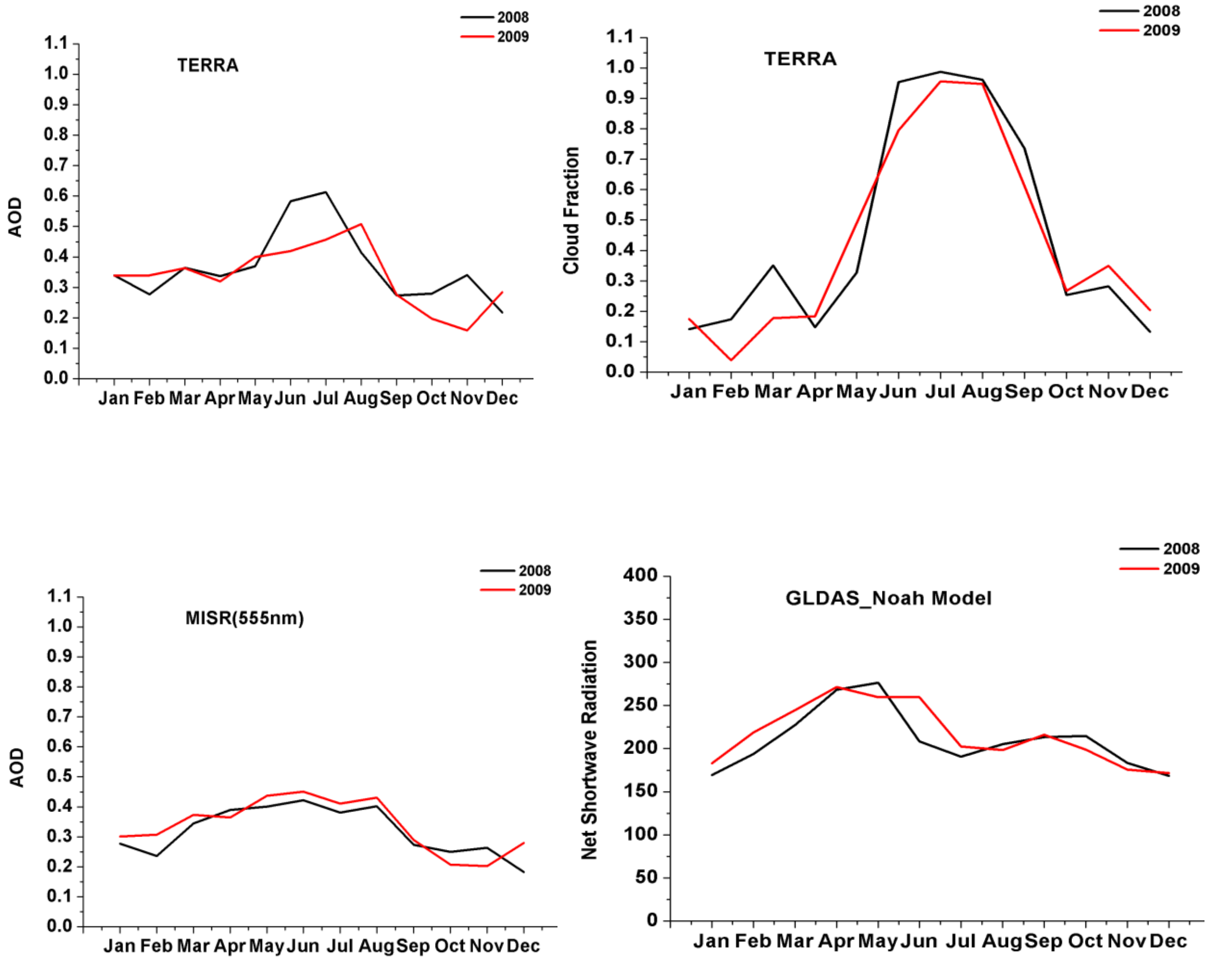

Figure 2. Monthly mean of AOD from TERRA and MISR, Cloud Fraction from TERRA and Net Short wave radiation from GLDAS for the year 2008 (black line) -2009 (red line) shown for Nagpur.

4.4 Variation of NO_2

Monthly variation of average NO_2 tropospheric column for the year 2008 -2009 is shown in Figure 3. Larger peaks observed in premonsoon for both the year and lowest in monsoon period. Lowest NO_2 concentration in monsoon may be due to washout effect that lowers the concentration NO_2 in the atmosphere NO_2 is showing seasonality. With increase in population numbers of vehicles also increased through which every day several tons of NO_2 is pumped into the atmosphere.

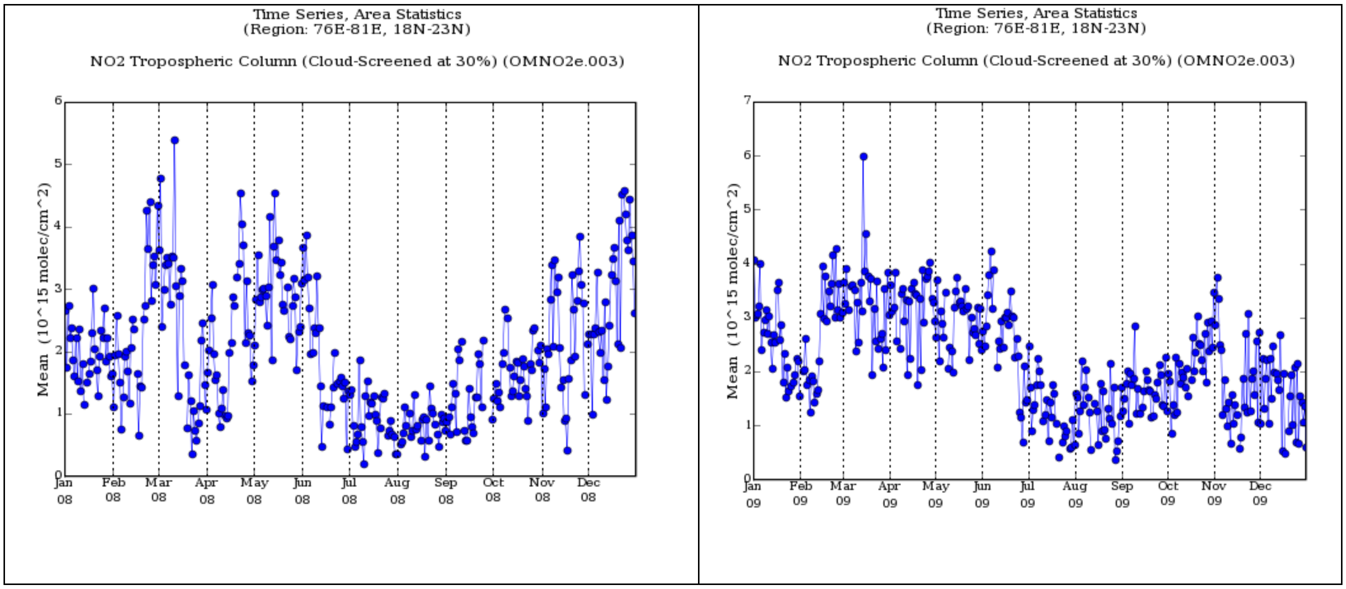

Figure 3. Monthly Variation of NO_2 tropospheric coloumn for the year 2008-2009

5. Conclusions

In the present study trend of net shortwave radiation was studied and it shown overall increasing trend after year 2000 with some abrupt values. This is mainly due to the measures taken for environmental protection. Enforcement of environmental legislation decreased the amount of aerosol load and use of catalytic converters in vehicles decreased the concentration NO_2. But for Nagpur in order to conclude anything precisely there is need to search in details the source of NO_2 and particulate matter. MODIS GLADS and OMI served a good source for study of solar radiation and atmosphere. But in combination with in situ observations it can able to give better results and understanding.

6. Acknowledgement

I want to acknowledge COSPAR for conducting this training program. I am thankful to R.P Singh for providing necessary guidance for the completing this project. I also want to thank Prof. N.C.Mahanti Head, Department of Applied Maths Birla Institute of Technology for his support. And I am very much thankful to Space Aplication Center (SAC), ISRO for necessary funding and support for my ongoing project.

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