International Training Workshop on

Atmospheric Aerosol: Observation, Modelling and Forecast

Organizer

CAS-TWAS Center of Excellence for Climate and Environment Sciences

International Center for Climate and Environment Sciences, IAP/CAS

National Satellite Meteorological Center, CMA

Sponsorship

Chinese Academy of Sciences

The World Academy of Sciences

The Commission on Science and Technology for Sustainable Development in the South

Ministry of Science and Technology of China

CAS International Cooperation Project on Climate Change Research and Observation

CAS Strategic Priority Research Program on Big Earth Data Science

July 18-20, 2019

Beijing, China

Welcome to ICCES-COMSATS Training Workshop

Dear Participants:

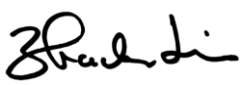
Atmospheric aerosols have substantially increased since industrial revolution, leading to severe environmental problems, and causing likely changes in heat waves, droughts, flooding, hurricanes and regional climate and hydrological cycle. The roles of aerosols in climate change are associated with large uncertainties due to lack of aerosol observational network, poor understanding of aerosol processes, and also their representations in air pollution forecast model and earth system models.

In order to enhance the capacity building for young scientists from developing countries to engage in aerosol observation and research on aerosol related issues, the International Training Workshop with the theme of **"Atmospheric Aerosol: Observation, Modelling and Forecast"** will be held on July 18 to 20, 2019 in Beijing. This year's workshop is organized by CAS-TWAS Center of Excellence for Climate and Environment Sciences (ICCES/ IAP) and jointly organized by the Commission on Science and Technology for Sustainable Development in the South (COMSATS) and National Satellite Meteorological Center (NSMC/CMA). It was jointly supported by COMSATS, Ministry of Science and Technology of China, CAS International Cooperation Project on Climate Change Research and Observation and CAS Strategic Priority Research Program on Big Earth Data Science.

The workshop will include the following four sessions:

Session 1: Aerosol-climate interaction
Session 2: Aerosol observation
Session 3: Air pollution Forecast
Session 4: Aerosol observation Platform

Sincerely Yours



Zhaohui Lin, Professor and Director

Local Organizing Committee

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Program

DAY 1			**Thursday, 18 July 2019**
Opening Ceremony	**9:00-9:20**	**Opening Remarks**	
	9:20-9:30	Prof. Zhaohui LIN	Introduction to the ICCES-COMSATS training workshop
	9:30-10:00	**Group Photo & Tea Break**	
Session 1 Aerosol-climate Interaction	**10:00-12:00**	Prof. Xiaohong LIU	Aerosol, Cloud, Climate, and Interactions in Earth System
12:00-14:00	**Lunch Buffet**		
Session 2a Aerosol Observation	**14:00-15:30**	Prof. Peng ZHANG	Fengyun Meteorological Satellites and Road map to service the Belt and Road Countries
	15:30-16:00	**Tea Break**	
	16:00-17:00	Prof. Peng ZHANG	Fengyun Meteorological Satellites and Road map to service the Belt and Road Countries
18:00-20:00	**Dinner Buffet**		
DAY 2			**Friday, 19 July 2019**
Session 2b Aerosol Observation	**9:00-10:30**	Prof. Jinyuan XIN	Building regional observation network to study air pollution problems
	10:30-11:00	**Tea Break**	
	11:00-12:00	Prof. Jinyuan XIN	Building regional observation network to study air pollution problems
12:00-14:00	**Lunch Buffet**		
Session 3 Air Pollution Forecast	**14:00-15:30**	Prof. Zifa WANG	Progress and Future Development of Air Pollution Forecast and Warning System over China
	15:30-16:00	**Tea Break**	

<table>
<tr><td></td><td>16:00-17:00</td><td>Prof. Zifa WANG</td><td>Progress and Future Development of Air Pollution Forecast and Warning System over China</td></tr>
<tr><td>17:00-17:30</td><td colspan="3">Certificate distribution and meeting summary</td></tr>
<tr><td>18:00-20:00</td><td colspan="3">Dinner Buffet</td></tr>
<tr><td colspan="4">Day 3 Saturday, 20 July 2019</td></tr>
<tr><td rowspan="8">Session 4 Aerosol Observation Platform</td><td>8:30-9:00</td><td colspan="2">Depart from the Hotel to NSMC</td></tr>
<tr><td rowspan="4">9:00-10:15</td><td colspan="2">Visiting National Satellite Meteorological Center, CMA</td></tr>
<tr><td>9:00-9:30</td><td>Feng Yun Meteorological Satellite Operation and Control Center</td></tr>
<tr><td>9:30-10:00</td><td>CMA Remote-sensing Application Center</td></tr>
<tr><td>10:00-10:15</td><td>Q & A session and Group Photo</td></tr>
<tr><td>10:15-10:50</td><td colspan="2">Depart from NSMC to IAP</td></tr>
<tr><td rowspan="3">10:50-11:40</td><td colspan="2">Visiting Institute of Atmospheric Physics, CAS</td></tr>
<tr><td>10:50-11:20</td><td>Beijing 325m Meteorological tower</td></tr>
<tr><td>11:20-12:00</td><td>ICCES & IAP main campus</td></tr>
<tr><td>12:00-14:00</td><td colspan="2">Return to the hotel & Lunch</td></tr>
</table>

General Information

1. Venue

The 2019 ICCES-COMSATS Training Workshop takes place in Beijing Friendship Hotel.

The Friendship Hotel of Beijing is one of the largest garden-style hotels in Asia. Located in the heart of Zhong Guan Cun Hi-Tech Zone, the Friendship Hotel neighbors many world famous tourist sites and universities such as Tsinghua and Peking University, the Summer Palace. It covers a total area of 335,000 square meters of land in the capital city, of which 200,000 square meters are landscaped gardening in the traditional Chinese garden style. The Friendship Hotel of Beijing represents classic Chinese architectural elegance and presents most pleasurable views.

Hotel Front Desk: 86-10-68498888

Webpage: http://www.bjfriendshiphotel.com/en

Meeting: Conference Room 5, 2nd Floor, Friendship Palace

Accommodation: Jing Bin Lou, Building No.2 *(Please make sure you contact LOC help to you make reservation before 10th July 2019)*

Dining:

Breakfast: The Juhe Restaurant, 1st Floor, Friendship Palace.

Lunch and Dinner: The Coffee Shop, 1st Floor, Friendship Palace.

2. Important dates

1.1 The Event

The 2019 ICCES-COMSATS Training Workshop lasts two and half days from 18 to 20 July 2019, which includes 2 days for in-house training and half day for site visiting. Please find details of the arrangement in program.

Day 1 In-house training	09:00 – 17:00	Thursday,18 July
Day 2 In-house training	09:00 – 17:00	Friday,19 July
Day 3 Observation Platform visiting	08:30 – 12:00	Saturday, 20 July

1.2 On-Site Registration:

Venue: At the desk outside Meeting room: Conference Room 5, 2nd Floor, Friendship Palace.

Time: 8:00 - 8:45 AM on Thursday 18 July 2019.

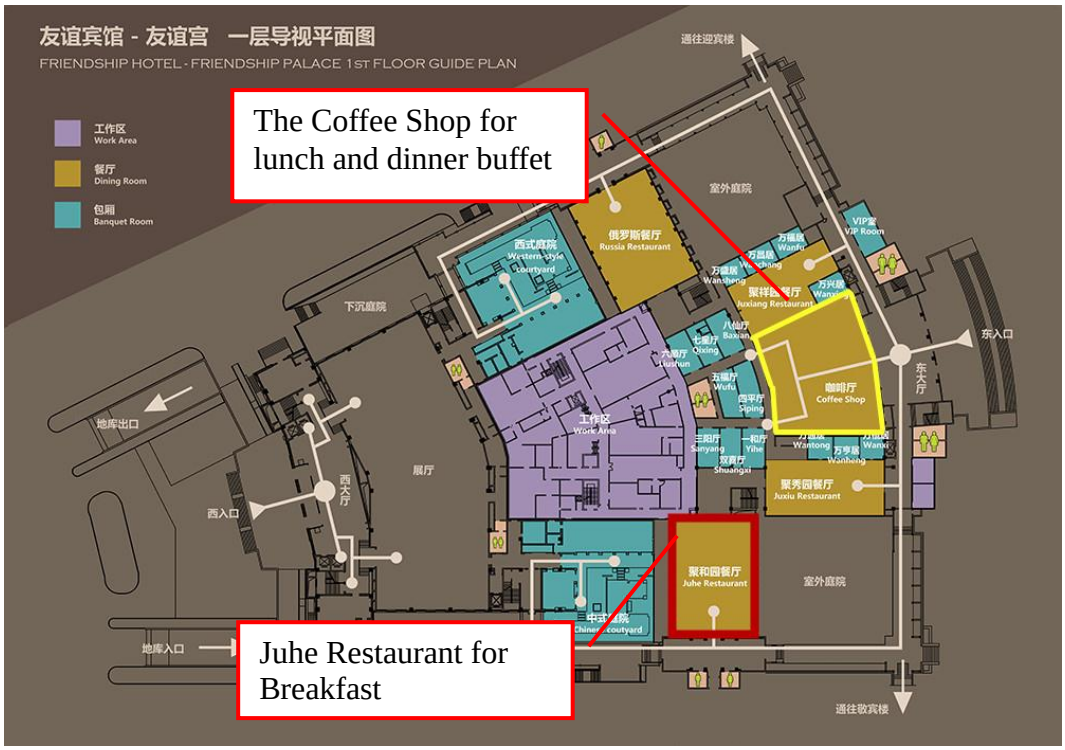
3. Map Guide

Please use these maps for you to find all the venues:

3.1 Beijing Friendship Hotel and buildings

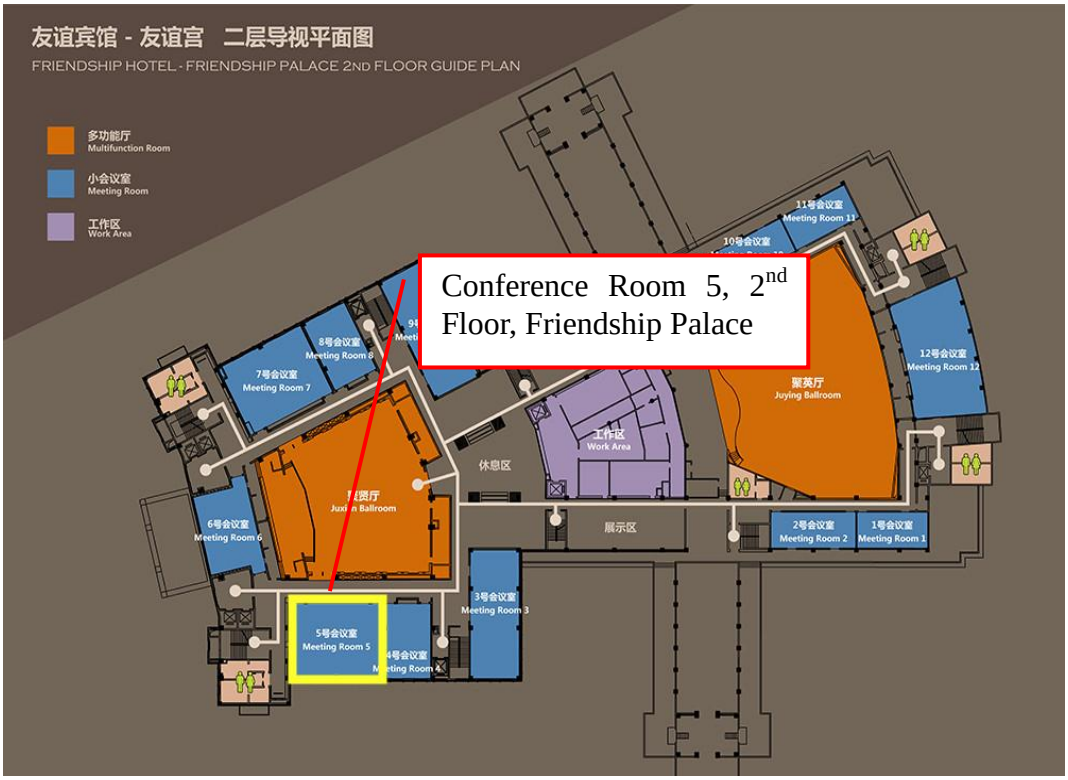
A Plan View of Beijing Friendship Hotel

3.2 Dinning places



A Plan view of 1st Floor, Friendship Palace

3.3 Conference room



A Plan view of 2nd Floor, Friendship Palace

4. Contacts

Conference Secretariat

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Lecture Materials

1. Professor Xiaohong LIU

Profile

Xiaohong LIU, Professor at the Department of Atmospheric Science, University of Wyoming. He is the Endowed "Wyoming Excellence Chair" in Climate Science. He is also an Affiliate Professor at the Institute of Atmospheric Physics, Chinese Academy of Sciences. He was a Senior Scientist at the Pacific Northwest National Laboratory from 2006 to 2013. He is the co-chair of the NCAR Community Earth System Model (CESM) Chemistry-Climate Working Group, and a core member of the development team of the Community Atmosphere Model, the atmosphere component of the CESM.

He conducts research in the fields of aerosol modeling and aerosol-cloud interactions, especially on cold cirrus and mixed-phase clouds. He has received awards and honors, including "Highly Cited Researcher" in 2014, 2015, 2016, 2017 and 2018 by Thomson-Reuters (now Clarivate Analytics), World Meteorology Organization Young Scientist Award in 2001, 100-Talent Plan of Chinese Academy of Science in 1997-1999, and Alexander von Humboldt Research Fellow in 1996-1997. He has published ~180 referred articles. He is an editor of the journal "Atmospheric Chemistry and Physics" and "Journal of Meteorological Research", and an associate editor of the "Journal of Geophysical Research – Atmosphere".

Abstract

Overview of Aerosol-Climate Interactions

The lecture begins with Mechanisms of aerosol-climate interactions, the lecture will start by asking the question to the students: what is the importance of aerosol on radiation, clouds, precipitation, and climate? I will briefly talk about the developments of aerosol and cloud microphysics representations in GCMs. The representation of warm cloud microphysics including droplet activation from aerosols will be discussed. I will point out the major issue of too high auto conversion rate relative to accretion rate in GCMs, which is one of the factors for too strong aerosol second indirect effects (e.g., aerosol lifetime effect). I will then talk about the cold-cloud microphysical processes in GCMs, including the representations of ice nucleation critical for the phase partitioning of cloud water into liquid and ice in mixed-phase clouds. Finally, I will show some observational evidences of aerosol effects on clouds and climate. Then, the lecture will focus on modeling studies of aerosol-climate interactions.it will start by introducing the different effects of aerosol on clouds and climate, including the radioactive effects due to aerosol-radiation interactions, due to aerosol-cloud interactions and due to aerosol induced surface albedo changes by deposition. I will highlight several modeling studies of aerosol-cloud-climate interactions conducted in my group and in the literature, including (1) anthropogenic aerosol effects on the springtime drought in East Asia, (2) dust effects on North American monsoon, (3) wildfire effects on convection, (4) absorbing aerosol effects on Southern Asian precipitation acting as heat pump, and (5) heating impacts of black carbon and dust deposition on Rocky Mountain snow packs on regional hydrological cycles.

2. Professor Peng ZHANG

Profile

Peng Zhang, Ph.D, Senior Scientist. Deputy Director–General of National Satellite Meteorological Center (NSMC/CMA) since 2013, Chief Director of FY-3 ground segment since 2013, Chair of Global Space Inter-Calibration System (GSICS) Executive Panel from 2014 to 2017, Chief Director of Chinese TanSat satellite ground segment since 2015, IEEE Senior Member since 2016, Chief Scientist of the National High Technology Research and Development Program of China for the space-based radiometric benchmark onboard calibrators (Grant No. 2015AA123700) from 2015-2017, Chief Scientist of National Key R&D Program of China for the retrospective calibration of the historical Chinese earth observation satellites (Grant No. 2018YFB0504900) from 2018-2022.

Dr Zhang got his Master degree at AIOFM/CAS (Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences) for atmospheric optics in 1995 and his Ph.D at IAP/CAS (Institute of Atmospheric Physics, Chinese Academy of Sciences) for atmospheric physics in 1998. From 1998 to 2001, Dr Zhang worked in EORC/NASDA (Earth Observation Research Center, National Space Development Agency of Japan) with Post Doctor position for GLI/ADEOS Ⅱ project. Since 2001, he worked in NSMC/CMA with Associate Professor (Nov., 2001 — Nov., 2005) and Professor (Dec., 2005 — Present) position. He is the visiting scholar at CMS/Meteo-France (Centre de Meteorologie Spatiale, Meteo-France) during Sept. 2003 to Dec. 2003. He is the visiting associate scientist at CIMSS/SSEC/UW-Madison (Cooperative Institute for Meteorological Satellite Studies, Space Science and Engineering Center, University of Wisconsin-Madison) during Feb. 2005 to Sept. 2005.

Dr. Zhang intensively involved in conceiving, developing, and operating FY-3 satellite ground segment. With his leadership, Chinese meteorological polar orbiting satellite FY-3 data have been used worldwide and the radiance calibration accuracy of the instruments mounted on the FY-3 has been improved greatly. His research experience covers the atmospheric remote sensing, satellite calibration and validation, and atmospheric radiative transfer calculation, etc. He has authored and coauthored over 90 papers published in refereed scientific journals to date, in addition to editing 2 Books and many book chapters and technical reports.

Abstract

Fengyun Meteorological Satellites and Roadmap to Service the Belt and Road Countries

Chinese meteorological satellites are named “FengYun” (FY), which means wind and cloud in Chinese. To acquire the measurements on the global and high temporal scales, FY series satellites maintain both a polar sun-synchronous orbit (polar hereafter) and a geostationary orbit (GEO) in space. The first polar satellite was successfully launched in 1988 and named FY-1A. The first GEO satellite was successfully launched in 1997 and named FY-2A. The names of FY series satellites are composed of an Arabic numeral and a letter, in which the numeral denotes the satellite series and the letter the sequence of the satellites within the series. In additional, odd and even numerals represent the FY polar (low earth orbit, LEO) and the GEO series satellites respectively. To date, 17 FY meteorological satellites have been launched. Currently, seven satellites are in operation/orbit.

To date, Chinese FY meteorological satellites have already transited from the first generation to the second generation in both their polar and GEO series. Different from the first-generation satellites, the current FY-3 satellites and FY-4 satellites are loaded with multiple advanced instruments to produce more comprehensive observations of the earth. The spectrum covers the ultraviolet, VIS, near IR, IR, and microwave wavelengths. The instruments cover optical imaging, atmospheric sounding, microwave imaging, hyperspectral trace-gas detection, full-band radiation budget monitoring, and space weather monitoring.

China has become one of few countries that maintain polar and GEO meteorological satellites operationally. With the associated open data policy and stable and accurate measurements,

the FY satellites are becoming an important component of the space-based global observing system. FY satellite data delivery services support direct broadcasting users, CMACAST users, and web portal users. Web portal users can obtain the data through an FTP push service, FTP pull service, or manual service. Users can access the data online (http://satellite.nsmc.org.cn/portalsite/default.aspx) after a quick and free-of-charge registration process.

In this presentation, the following information has been introduced: 1) Retrospect and prospect of meteorological satellite, 2) Fengyun program overview, 3) Current and future Fengyun program, 4) Instruments and products, 5) Data delivery services, 6) Global monitoring applications.

3. Professor Jinyuan XIN

Profile

Prof. Dr. JINYUAN XIN was born in 1975. The research field is in atmospheric physics and atmospheric environment. He obtained the bachelor and master degrees in atmospheric physics and atmospheric environment, the doctorate degrees in meteorology in Lanzhou University in 1999, 2002 and 2007, respectively. Then he worked into the Institute of Atmospheric Physics, Chinese Academy of Sciences. He is the director of the Analysis and Testing Center, the associate director of the Service Center of Public Technology of IAP, CAS, a member of the Medical Meteorology Committee of the Chinese Meteorological Society, and an Associate Editor of Atmospheric Research.

Based on the network job, he has taken charge of ten research projects from NSFC, MOST, CAS, and Beijing government. He was funded by the Excellent Young Scientist Foundation of NSFC. He published 130s papers (including 87 SCI papers, IF adds up 350) the fields of aerosol optical, atmospheric physics and atmospheric environment, which were cited by more than 2100s SCI papers. He won some academic awards, e.g. Youth Meteorological Science and Technology Award of Chinese Meteorological Society, the Innovation Award of XueDuFengZheng, the Excellent Young and Middle-aged Science Award of ZhaoJiuZhang and the first prize of Science and Technology in Beijing.

Abstract

Building regional observation network to study air pollution problems

Since 2004, we have been working on the research networks to investigate aerosol optical, physical and chemical properties, and atmospheric pollutants throughout China. We built the networks with great efforts, and systematically revealed the temporal and spatial distribution and the trends for the aerosol properties and uncovered the change and influence of atmospheric pollution. We discovered that the proportion of fine particle increased markedly with nationwide industrialization development. The sky was dimming over the eastern China, with significant increasing of aerosol optical depth. The high-concentration industrial aerosol was strongly cooling the atmosphere-surface system throughout years, which cloud have changed the thermodynamic structure and reinforced the regional atmospheric stability. The booming industrialization has confused the environment and climate change in China. In the urban agglomeration of North China, we found that the regional jointly implemented control measures could efficiently improve the air quality. Meanwhile, we found the PM2.5 threshold for aerosol extinction in the megacity. The networks' results have been used to verify nine satellites and ten models, which fills the gaps of aerosol network and improves the satellite inverse technique and the model simulation technology in China.

The networks open to scientists around the world. You are welcome to develop the scientific value of the networks together. If you want to use the data, please contact with me at any time. (Email: xjy@mail.iap.ac.cn)

4. Professor Zifa WANG

Profile

Professor Zifa Wang is Director of the State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry (LAPC) of the Institute of Atmospheric Physics, Chinese Academy of Sciences, the editor of Chinese Journal of Atmospheric Sciences, Aerosol and Air Quality Research, The Scientific World JOURNAL and SOLA Journal. He was in charge of air quality modeling and forecast for the Beijing Olympics in 2008, the Shanghai World Expo 2010, the Guangzhou Asian Games 2010, and the APEC Beijing 2014. He has developed a nested air quality prediction modeling system (NAQPMS), which is a tool to study air pollution such as Asian dust storms across a regional and urban scale and is widely used in China including MEP, Beijing, Tianjin, Hebei, Jiangsu, Shanghai, Guangzhou, Zhengzhou, Shenzhen, and others, as a real time forecasting model of air quality. This model was included in a multiple model inter-comparison project MICS-Asia III. He studied and worked in Japan from 1998 to 2002 and got his PhD in Atmospheric Physics in 1997.

His research is focused on the study of atmospheric environment and modeling in the past 20 years. He has developed a nested air quality prediction modeling system (NAQPMS) for air pollution study, such as Asian dust storms and air quality forecast. This model has been widely used in most cities including Beijing, Shanghai, Zhengzhou, Shenzhen, Shenyang, and etc., for real time forecasting of the air quality. This model was also involved in a multiple model inter-comparison project (MICS-Asia) to investigate the transport and deposition mechanisms of atmospheric pollutants including ozone, and the Asian dust particles. He has operated air-quality modeling projects across China and has conducted air quality forecasting in many international field campaigns, such as CARE Beijing, PRD, LTP, etc. He was in charge of the air quality modeling and forecast for the Beijing Olympics in 2008. The Ensemble air quality forecast Modeling System (EMS) designed by him, after successfully applications to air quality forecast during the Beijing Olympics 2008, the Shanghai World Expo 2010, the Asian Games 2010, the G20 Hangzhou, has been widely used in the national

level, regional, province .He has published 270+ SCI papers as author and co-author with a total citation of 7600+. His H-index is 47.

Abstract

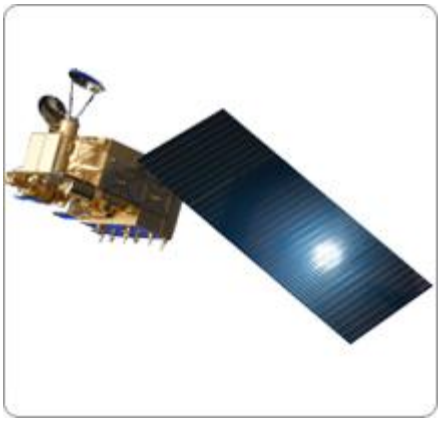
Regional air quality modeling and its control over mega cities in China

China is now considered to be the engine of world's economic growth, with the annual growth rate of the gross domestic product (GDP) reaching to about 10% in the last three decades. The economic growth has been accompanied by the emergence several mega city clusters with huge urban area populations, which has resulted in tremendous increase in energy consumption, emissions of pollutants and regional air pollution problems over these mega cities, such as Beijing, Shanghai, the Yangtze River Delta region, and the Pearl River Delta region. Currently the Beijing and its surroundings afford a high level air quality with more than 10 years efforts based on the modeling and control. Many air pollution studies have been conducted with field measurements, lab experiments, numerical modeling and control tests. Based on these previous studies, the presentation affords the current state of the understanding of regional air quality problems, including emission, formation, transport, deposition of pollutants, and the challenges to modeling and controlling air pollution in China.

Observation Platform

1. The National Satellite Meteorological Center (NSMC)

NSMC was founded in 1971. It is one of the operational centers of China Meteorological Administration (CMA) and responsible for receiving, processing the data of Chinese and foreign meteorological satellites, and distributing the data and information products to users for application. NSMC consists of a headquarter in Bejing and five ground satellite receiving stations, which are located in Beijing, Guangzhou,Wulumuqi, Jiamusi, and Kashi respectively.



FY-3 satellites are China's second generation polar-orbiting meteorological satellites, with substantively enhanced functionalities and technical capabilities. They are designed to enhance China's three dimensional atmospheric sounding capability and global data acquisition capability, in an effort to collect more cloud and surface characteristics data, from which meteorologists may infer out atmospheric, land surface and sea surface parameters that are global, all-weather, three-dimensional, quantitative, and multi-spectral. FY-3 meteorological satellites have their applications mainly in the following four aspects:

1) Provide global meteorological parameters with a balanced resolution to numerical weather prediction;

2) Provide diverse meteorological and geophysical parameters to global change studies, including climate variation studies, and to climate projections;

3) Monitor large-scale natural disasters and surface ecological environment;

4) Provide weather information on any part of the world for specialized activities, including aviation, marine activities among others, and provide meteorological support for national defense.

2. Meteorological Tower Experimental Platform

The meteorological tower experimental platform is a low-level atmospheric comprehensive detection system, which integrates multi-layer and multi-parameter observation systems to realize comprehensive automatic observation of atmospheric flux, atmospheric composition, meteorological field and other parameters within 300m height, and can be based on different projects. Additional observation projects are needed. The main equipment for daily operation include: Meteorological mean field observation system (15 layers), imported turbulent flux observation system (5 layers), self-developed ultrasonic wind speed thermometer observation system (3 layers), automatic weather station observation system (ground and Observation equipment such as soil), atmospheric pollutant observation system (4 layers), and 325 meters of iron tower towers, elevators, etc., the overall value of the equipment is more than 5.4 million CNY.

As an open experimental platform, the meteorological tower itself has realized many related scientific research units (such as the Meteorological Science Research Institute of the National Meteorological Administration, the Beijing Institute of Urban Meteorology, the Chinese Academy of Environmental Sciences, the Academy of Military Medical Sciences, Peking University, Nanjing University). Tsinghua University, Beijing University of Technology, Beijing Third Hospital, etc. shared and shared, and participated in many observational experiments of large state affairs. In addition to the external sharing of the experimental platform, in 2010, more than 19,000 days of basic observations were provided to both inside and outside.

Introduction of the Organizer

1. CAS-TWAS Center of Excellence, International Center for Climate and Environment Sciences

The CAS-TWAS Center of Excellence, International Center for climate and Environment Sciences (ICCES), was founded in 1991. It was selected as the representative center of China to join the network of Centre of Excellence of COMSATS (Commission on Science and Technology for Sustainable Development in the South) in 1995, and also one of the centers of Third World Network of Scientific Organizations (TWNSO). Besides, ICCES also holds the secretariat of CAS-TWAS-WMO Forum (CTWF) on Climate Science, and has organized 10 international workshops and 2 training workshops since 2000.

ICCES focuses its research on the key scientific problems related with global climate and environmental changes. The main research fields includes the development of Dynamical Earth System Model and numerical simulation, meteorological and environmental forecast and related disaster assessment theory and technique, data assimilation theory and methodology, and earth system theory and natural cybernetics. Currently, there are more than 60 ongoing research projects in ICCES, which are mostly funded by the Ministry of Science and Technology of China (MOST), Chinese Academy of Sciences, and the National Natural Science Foundation of China (NSFC). ICCES has comprehensive international cooperation with research institutions in the developing and developed countries, and is the one the first CAS training centers for international students.

ICCES has a team of 54 staff in total, including one Academician, 14 professors, 2 senior engineers and 11 associate professors. Besides, ICCES also has 9 postdocs and around 40 PHD and graduate students.

CAS-TWAS International Center for Climate and Environmental Sciences practices a director responsibility system, which is under the leadership of administration committee composed of personnel from Chinese Academy of Sciences, Institute of Atmospheric Physics and relevant departments. A Scientific Steering Committee determines the scientific goals and oversees the research activities, international cooperation and training programs.

ICCES is made up of the research unit, the international cooperation unit and the central office, among which the research unit carries out the innovative research, the international

cooperation unit takes responsibility for the international cooperation and exchanges, and talent training, and the central office provides the necessary support for these activities.

ICCES is devoted to establishing the cooperative and innovation research center of CAS and TWAS in the area of climate and environment sciences, and provide services to the developing countries with scientific support and advisory, capacity building, etc.

The main tasks of ICCES are:

1) Researches on the key scientific problems in global climate and environmental changes, such as theories, simulation and prediction of global change, disaster detection and assessment, etc, Promotes the capability of monitoring and forecasting of climatic and environmental disaster, and provides services for the national and international requirements on sustainable developments, as well as consultation for scientific policies in the negotiation of global climate change.

2) Organizes the CTWF international workshops and training workshops, provides exchange programs for international visiting scholars and students from developing countries, and fosters key international cooperative projects on the research of climate and environmental change, to strengthen the capacity of related research, and improve the understanding of climate change as well as the experiences of management and adaptation in the developing countries.

The goal of the Center is to become an international renowned research center on global climate and environmental sciences, as well as a cooperative base providing technology support, capacity building and talent training for developing countries, to take the lead in initiating, organizing, coordinating and implementing major international scientific cooperation between CAS and other developing countries, and hence to promote TWAS's influence in the international community of science and technology, especially in the global climate and environmental change research.

2. Commission on Science and Technology for Sustainable Development in the South (COMSATS)

COMSATS is an international/inter-governmental organization aiming at sustainable socio-economic uplift of the developing countries through the judicious application of science and technology. South-South and Triangular Cooperation are the major mechanisms adopted by the organization to achieve its objectives. COMSATS currently comprises of 27 developing countries, including 13 from Asia, 12 from Africa and 2 from Latin America. These are: Bangladesh, China, Colombia, Egypt, Gambia, Ghana, Iran, Jamaica, Jordan, Kazakhstan, Korea (D.P.R.), Morocco, Nigeria, Pakistan, Palestine, Philippines, Senegal, Somalia, Sri Lanka, Sudan, Syria, Tanzania, Tunisia, Turkey, Uganda, Yemen and Zimbabwe. The membership of COMSATS is open to all developing countries. Hon. Nana Addo Dankwa Akufo-Addo, President of Republic of Ghana, is the incumbent Chairperson of COMSATS.

The idea of establishing a high-level Commission on science and technology for countries of the South was conceived by Pakistani Nobel Laureate, Prof. Dr. Abdus Salam, recognizing the increasingly widening gap of scientific knowledge and economic development between the North and the South. It was realized that sustainable socio-economic development in the South cannot be achieved without building and sustaining indigenous capacities in science and technology. The foundation meeting of the Commission was held in Islamabad on 4th and 5th October 1994, which was hosted by the Government of Pakistan, which led to the establishment of COMSATS and the Network of International S&T Centres of Excellence. The Secretariat/Headquarters of the organization is based in Islamabad, Pakistan.

COMSATS' major source of scientific and technological strength lies in its Network of International S&T Centres of Excellence. The Heads of these Centres constitute the Coordinating Council of COMSATS, which meets every year in order to discuss the ongoing programmes and chalk-out the way forward. All of the programmes and activities of COMSATS are directly or indirectly linked with the Sustainable Development Goals.

Over the years, COMSATS has implemented various programmes. Realizing that there was no Internet infrastructure in Pakistan, the organization established the COMSATS Internet Services (CIS) in 1996, which is currently providing services to 17 major cities of the country. CIS has offered to provide consultancy and training services to institutions in COMSATS'

Member Countries that may wish to launch any service offered by CIS.

COMSATS established the COMSATS Institute of Information Technology (CIIT) in Islamabad in 1998 in order to deliver technical and higher education in this field. The institute has now been renamed as COMSATS University Islamabad (CUI), having campuses in seven cities of Pakistan. The university has over 40,000 students and a very strong teaching faculty. It is among the top five universities of Pakistan, and at top most position in the field of 'Computer Science and Information Technology'. CUI offers 100 scholarships for students from COMSATS Member States, and currently 400 international students from 16 countries are studying in its various campuses. The university is working in collaboration with various countries of the South and North for a number of academic and research programmes. CUI is an excellent instrument to enhance South-South and Triangular cooperation.

COMSATS launched Telehealth Programme (CTH) in 2001 in order to cater the needs of patients in the remote areas of Pakistan. More than 55000 online consultations have been carried out under this programme.

COMSATS is also facilitating joint research projects in various fields of science and technology in order to collectively address the common challenges being faced by the Member States. These International Thematic Research Groups (ITRGs) comprise of research scientists belonging to various developing countries. The key activities are in the fields such as information and communication technologies; agriculture, food security and biotechnology; natural products sciences; renewable energy; mathematical modeling; and climate change and environmental protection. Apart from joint research projects, COMSATS' ITRG programme provides a platform for expert-exchange and sharing of laboratory resources among the member institutions. Moreover, opportunities of short-term trainings are provided to the group members in order to build their capacity in the target area and enable them to perform their research assignments more effectively.

COMSATS has been actively supporting the capacity building of the developing countries. More than 300 capacity building events have been organized in various member countries in the fields such as agriculture and food security, climate change, cyber security, repair and maintenance of scientific instruments, industrial research, health, ICTs, renewable energy, etc. Various policy dialogues have also been organized by the organization, which are aimed at strengthening the capability of senior academicians, researchers and planners from the

developing countries to develop national policies, as well as to enable them to respond effectively to the challenges during rapid globalization and technological change. Moreover, the Centres of Excellence of COMSATS offer post-graduate scholarships, post-doctoral fellowships and short-term trainings to the Member States.

The COMSATS Centre for Climate & Sustainability (CCCS) was launched in August 2018, which is focused at establishing a network of centres that would be working on the linkages of climate change and sustainable development. This network of CCCS institutional frameworks would work with regional countries or at the inter-regional level to build more capacity and expertise in addressing common challenges. As of now fourteen member states have agreed to establish CCCS in their respective countries.

COMSATS is also striving to establish new state-of-the-art research centres/universities and upgradation of the existing institutions in the developing countries. In this regard, consultations are underway with the governments of China, Nigeria, Sri Lanka, Ghana, etc.