



Project Atmospheric Brown Cloud UPDATES

Prepared by the ABC Science Secretariat
<http://www-abc-asia.ucsd.edu/>

We are looking for contributions to ABC Updates. Please email submissions to nicole@fiji.ucsd.edu

MALDIVES CLIMATE OBSERVATORY

The Maldives Climate Observatory on the island of Hanimaadhoo opened in October 2004 as part of the APMEX campaign. The observatory will measure atmospheric conditions regularly and was enhanced with aerosol and radiation instruments during the APMEX campaign. See ABC OBSERVATORIES page 4.



FUNDING FROM SIDA

The Swedish International Development Cooperation Agency (SIDA) agreed to provide \$2.98 million toward funding of the ABC project over a period of three years. The support began in November 2004.

NEXT ABC MEETING

The ABC science and policy secretariat teams plan to meet in China next spring to discuss future sites for the project. The location and time of the meeting will be announced in an upcoming edition of ABC Updates.

ABC IN KOREA?

ABC soon will operate a site in Korea. The site will provide more information about atmospheric conditions in Northern Asia. Look for more information in future editions of ABC Updates.

APMEX CAMPAIGN LAUNCHED

The ABC science team launched the ABC Post-Monsoon Experiment (APMEX) in October 2004. The experiment augmented standard atmospheric observations and focused on radiation and the changing aerosols in the atmosphere during the transitional monsoon period. See APMEX CAMPAIGN page 2.

FIRST FLIGHT OF THE ABC AUAV

The ABC Autonomous Unmanned Aircraft Vehicle flew fully loaded instrument flights in the Maldives on the island of Hanimaadhoo during the APMEX campaign. The flights were designed to provide a vertical profile of the atmosphere. See AUAVs page 6.

OUTREACH ASIA

The ABC science team joined forces with the Maldivan Government to teach a selected group of Asian students about atmospheric aerosols and the instruments used to measure them. The school took place in the Maldives during the APMEX campaign. See CAPACITY BUILDING page 7.



APMEX CAMPAIGN

INTRODUCTION

The ABC Post-Monsoon Experiment (APMEX), executed in October of 2004, was a great achievement for climate research. Dr. V. Ramanathan of Scripps Institution of Oceanography at the University of California, San Diego, spearheaded this project with a team of scientists from several universities around the world. The month-long project began with the opening of a new observatory in the Maldives on the native island of Hanimaadhoo where a series of intensive surface observations were conducted and served as the launching point for an aviation platform upper-atmosphere program. Collaborators from around the globe contributed to the funding, administration, and scientific research of this project.

OBJECTIVES

Surface and aircraft observations were collected to accomplish these ABC objectives:

- Understanding long-range transport of black carbon
- Understanding how ABCs fill the North Indian Ocean as the ITCZ retreats from the North to the South Indian Ocean
- Examining the link between aerosols and cloud microphysics to compare the indirect effect during the post-monsoon with that observed during INDOEX
- Validation of regional aerosol-chemical-transport models.



Hanimaadhoo, Maldives, November 2004

CAMPAIGN HIGHLIGHTS:

- Successful initiation and operation of the ABC-Super Observatory on Hanimaadhoo;
- BC measurements by five independent techniques including single-particle, cavity ring-down, filters, aethalometers, and radiometric techniques;
- Twelve flight days of Dornier aircraft that sampled air masses from almost all regions of Asia, including data on black carbon and aerosol indirect effects;
- Flights of AUAV that sampled air in a vertical profile;
- Continuous observations of direct solar radiation by Kipp-Zonen and Eppley-Pyrheliometers to estimate the uncertainties in global dimming studies;
- Determination of ABC-induced dimming by five independent radiometers and spectrometers to define its spectral nature; and
- Validation of aerosol-chemical transport models, including validation of recent BC emission estimates by ABC scientists.

PROJECT INTRODUCTION FROM CHIEF SCIENTIST

I am delighted that APMEX, the first campaign of ABC, began on October 1 of 2004. Here is a brief overview of the activities at Maldives and elsewhere.

APMEX began on October 1, 2004 and lasted until November 15, 2004. October is the month of transition when winds in the North Indian Ocean and the Arabian sea change from south-westerly during June to September (bringing monsoon rains to South Asia) to northerly and northeasterly winds, bringing aerosols from much of South and Southeast Asia to the Arabian sea, the Bay of Bengal, and the North Indian ocean. By making intense observations during this important transition period, we can gain needed insights into how we as humans are negatively impacting our planet. The first of October was also the official starting date of the ABC super site at Maldives. This facility is a unique observatory in the Indo-Asian-Pacific region and is a major site for the study of air pollution, aerosol, radiation, cloud, and precipitation-chemistry observations. It is our vision that the Maldives super site will serve as a long-term observatory and as an early warning site for South Asia.

The following major activities occurred during the APMEX

campaign:

- A. First operation of the Maldives super site;
- B. Field experiment consisting of three components:
 - 1) Surface based observations from ABC observatories,
 - 2) Manned aircraft observations using Island Aviation twin engine turboprop aircraft to sample aerosols and clouds, and
 - 3) Unmanned aircraft observations for vertical profiling of aerosols and radiation, unique to ABC;
- C. Instrument intercomparison and model validation; and
- D. Training program for next generation of South Asian scientists.

APMEX proved to be an exciting campaign with the potential for major findings of relevance to the over 2 billion people living in South and Southeast Asia, thanks in large part to my ABC colleagues in the U.S., Europe, and East, Southeast, and South Asia.



Dr. V. Ramanathan



Instruments at the ABC Maldives Climate Observatory, Hanimaadhoo, Maldives, November 2004

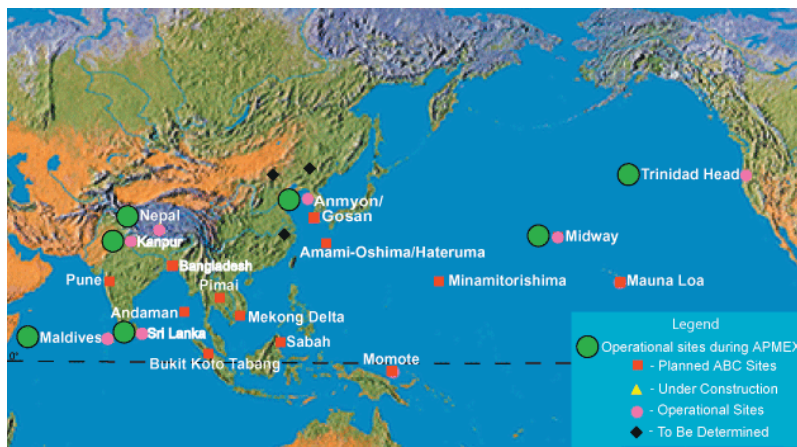
ACKNOWLEDGEMENTS

The Science Secretariat is indebted to Mr. Hung Nguyen of Scripps, Mr. Abdullahi Majeed and Mr. Amjad Abdullah of the Maldivian Ministry of Environment and Construction, and Mr. Ahmed Inthikab of Island Aviation for making this campaign a success. In a campaign such as this, it is difficult, if not impossible, to single out any group, but we are truly impressed with the enormous cooperation and team spirit shown by Island Aviation, including their pilots, engineers, and ground staff. We also wish to thank our most gracious hosts at Hanimaadhoo Village and the ever smiling and helpful Village Chief. Our campaign coincided exactly with the one-month Ramadan period and we stressed all of their resources to the limit. We also are grateful for the immense help of our team at Scripps. Of course, my deep gratitude goes to the National Oceanic and Atmospheric Administration for funding the observatory and part of the campaign and to the National Science Foundation and The Vetlesen Foundation for funding portions of the campaign and the modeling studies.

ABC OBSERVATORIES

Almost two dozen sites located throughout South and South East Asia make up the ABC observatory network. Some sites have yet to be initiated and others are fully operational. The locations of these sites around the Northern Indian and Northern Pacific Oceans are such that they attempt to give us a complete picture of the atmospheric flow in these regions.

The observatories will record continuous chemical and microphysical aerosol observations at key locations in the Indo-Asian-Pacific region with a particular emphasis on black carbon, organics, and cloud condensation nuclei. A major thrust of these observatories will be characterization of the sources of these aerosols based on the analysis of aerosol filters for molecular markers and single-particle analysis. Identified sources from these molecular markers will include bio-fuels and other forms of biomass burning; coal combustion; and diesel and two-stroke engines. The source characterization will be used by the United Nations Environment Programme and the region's governments in order to develop future strategies for mitigating the impact of Asian air pollution on climate, human health, and the environment.



Map of ABC observatories



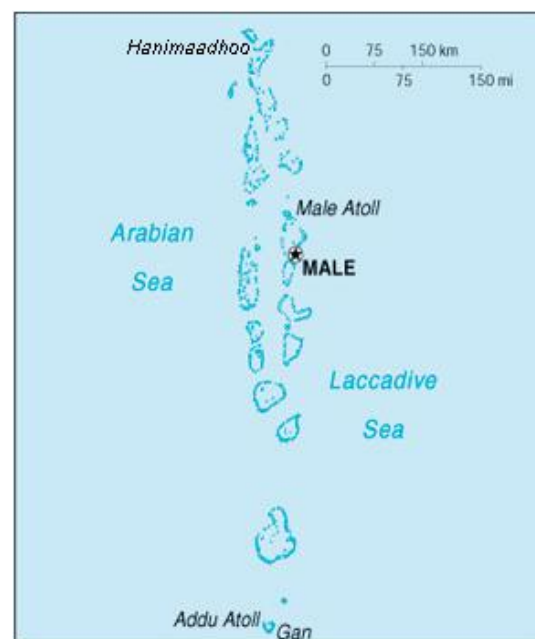
ABC Maldives Climate Observatory, Hanimaadhoo, Maldives, November 2004

MALDIVES CLIMATE OBSERVATORY HANIMAADHOO (MCO-H)

The Maldives Climate Observatory on Hanimaadhoo (MCO-H) is an ABC super-observatory. It is situated on one of the Northern-most islands of the Maldives. This location was chosen so that the Northwest atmospheric flow can be studied with minimal influence from the surrounding islands. It will play an important role in measuring the characteristics of air that moves down from the coast of India.

MCO-GAN

The atmospheric flow reaching MCO-H will be influenced by other Maldivian islands when the wind comes from southern sectors. Since Gan is the southern-most island of the Maldives archipelago, the satellite observatory (MCO-G) will measure pristine oceanic aerosols during the southwest monsoon flow.



Simple map of the Maldives

SURFACE-BASED OBSERVATIONS

Aerosol and radiation observations occurred at: Hanimadhoo and Gan Islands, Maldives; Kanpur, India; Colombo, Sri Lanka; Katmandu, Nepal; and Sri Samrong, Thailand. The following nations and institutions participated in the experiment:

- Observations in Maldives (Hanimaadhoo and Gan)
 - U.S.: Scripps Institution of Oceanography, University of California, San Diego (UCSD); University of Wisconsin; University of Miami; NASA-Ames; and NASA-Goddard;
 - Sweden: University of Stockholm;
- Observations in India
 - India: Indian Institute of Technology at Kanpur;
 - U.S.: Scripps Institution of Oceanography, UCSD; and NASA-Goddard;
- Observations in Sri Lanka
 - Sri Lanka: Meteorological Department at Colombo;
 - U.S.: Scripps Institution of Oceanography, UCSD;
- Observations in Nepal
 - Nepal: ICIMOD at Katmandu;
 - USA: Scripps Institution of Oceanography, UCSD;
- Observations in Thailand
 - Thailand: Chulankong University, Bangkok.



Instrument tower at the Maldives Climate Observatory, Hanimaadhoo, Maldives, November 2004

SURFACE INSTRUMENTATION AT MCO-H

CORE AEROSOL INSTRUMENTS

TSI CPC
 TSI Nephelometer
 Magee aethalometer
 TSI APS
 TSI SMPS
 Filters, ambient

APMEX CAMPAIGN AEROSOL INSTRUMENTS

2 Ecotech Nephelometers
 Magee Aethalometer
 ATOFMS
 SMPS/APS
 Cadenza (NASA)

RADIATION INSTRUMENTS

Sun Tracker
 Sun Sensor
 Pyranometer
 Pyranometer
 Pyrgeometer
 Ventilation Systems
 Pyrliometer
 Pyrliometer
 FieldSpec-HandHeld Grating Spectrometer
 BSI-GUV2511

Kipp & Zonen
 Kipp & Zonen
 0.2 to 2.8 μm
 0.2 to 3.6 μm
 4.5 to 42.0 μm
 CV2 type
 0.2 to 4.0 μm
 (calcium florid window, quartz window)
 325 to 1075 nm
 303, 320, 330, 340, 380, 400-700 nm

AIRCRAFT OBSERVATIONS



*Dornier Aircraft of Island Aviation Services, Ltd., Maldives,
November 2004*

DORNIER FLIGHT PROGRAM

The objectives of the aircraft program were:

- to collect data on the indirect effect of aerosols;
- to examine the vertical distribution of aerosols and infer modes of long range transport; and
- to examine the vertical distribution of BC.

Between October 15th and November 10th, 65 hours of aerosol and cloud microphysical data were collected from Island Aviation Dornier aircraft instrumented by the University of Miami and Scripps Institution of Oceanography. We were remarkably successful with this limited time to sample air masses coming from South and Southeast Asia, and also from East Asia.

LIGHT AIRCRAFT AEROSOL PACKAGE (LAAP) AEROSOL INSTRUMENTS

Number Concentration, #; 15-1000 nm, TSI 3760
Number Size Distribution, #; 0.5-5.0 μm , MetOne 237B
Number Size Distribution, #; 0.1-1.0 μm , MetOne 237H
Light Absorption, bap, RR PSAP
Light Scattering ($<10 \mu\text{m}$), bsp, RR M903 Neph
Light Scattering ($<1 \mu\text{m}$), bsp, RR M903 Neph
Bulk Filter Sampler, chemistry, inline filter holder

AUXILIARY INSTRUMENTS

Ozone (concentration) by 2B Technologies
Location (lat/long) by Garmin GPS III Pilot
Altitude (Patm) by Viasala Sensor
Instrument pressure (pressure) by Neph Sensor
Ambient T/RH (T/RH) by Viasala Sensor
Instrument T/RH (T/RH) by Neph Sensor



*AUAV (foreground) with van-top launcher (background)
Hanimaadhoo, Maldives, November 2004*

AUAV FLIGHT PROGRAM

The Autonomous Unmanned Aerial Vehicle (AUAV) was deployed from Hanimaadhoo Airport on Hanimaadhoo island during the APMEX campaign. The payload included a condensation particle counter, optical particle counter, two pyranometers (upward and downward pointing), aerosol inlet, and data acquisition system. Several flights were conducted to obtain vertical profiles of aerosols and radiation.

CAPACITY BUILDING IN SOUTH ASIA



ABC training school students and lecturers outside the Maldives Climate Observatory in Hanimaadhoo, Maldives, October 2004

Co-chaired by Drs. Jayaraman and Ramanathan, a 10-day South Asian training program taught participants from many regions of South and Southeast Asia. Drs. Crutzen, Jayaraman, Kim, Nakajima, Ramanathan, and Yoon presented lectures to the students. In addition, the students obtained hands-on training in running the observatory instruments from Drs. Corrigan, Kim, and Ramana. The students collected data at the observatory, analyzed the results, and presented their papers as requirements for completing the program. Dr. Jayaraman of the Physical Research Laboratory, Ahmedabad, India, organized the training program.

Maldivian personnel received hands-on training in the scientific objectives of the observations and in running the instruments.

Discussions have begun with the Maldivian government to expand the observatory into an early warning system of climate and environmental changes for the Maldives and the tropical Indian Ocean region.

LECTURES DELIVERED TO TRAINING SCHOOL OCTOBER 6 - 10, 2004

Lecture 1: Introduction to Earth's Climate System (V. Ramanathan)

Lecture 2: Atmospheric Chemistry in the Anthropocene (P. J. Crutzen)

Lecture 3: Interaction of Solar Radiation with the Earth's Atmosphere (A. Jayaraman)

Lecture 4: Aerosol Radiation Interaction: Aerosol Optical Properties (D. Kim)

Lecture 5: Aerosol Climate Interaction (V. Ramanathan)

Lecture 6: Aerosol Measurements (A. Jayaraman)

Lecture 7: Aerosol Radiative Forcing (D. Kim)

Lecture 8: The Role of the Tropics in Tropospheric Chemistry (P. J. Crutzen)

Lecture 9: Optical and Chemical Properties of East Asian Aerosols (S. C. Yoon)

Lecture 10: The Atmospheric Brown Cloud (A. Jayaraman)

Lecture 11: Issues for Science Researchers Relevant for the ABC Gosan Campaign (T. Nakajima)

INSTRUMENT INTERCOMPARISON AND VALIDATION

The major new attempt of this step was to compare BC measured by a single particle instrument (ATOMFS), cavity-ring down instrument, filter-based measurement, and the standard aethalometers. In addition, we took simultaneous measurements of solar fluxes by Kipp-Zonen (used in European data sets) with Eppley Pyranometers (used in US data sets). This step will enable us to understand the uncertainties in global dimming measurements.

MODEL INTERCOMPARISON AND VALIDATION

The study included regional chemical-transport models from the University of Iowa and MPI-Mainz. Both models conducted real-time simulations of aerosols and gases. The data collected on aerosol optical depths, aerosol chemistry, BC, and vertical distribution of aerosols will be used to validate the models.

BC AND SO₄ EMISSIONS FROM SOUTH ASIA

In preparation for the campaign, TERI (India) and Scripps (La Jolla) collaborated to make new state-by-state emission estimates of BC and sulfates. This data will be used in the University of Iowa regional model to determine if it improves the comparison with observed data.

PARTICIPATING INSTITUTIONS

Center for Clouds, Chemistry, and Climate, SIO, UCSD, California, USA
 China Academy of Meteorological Sciences, Beijing, CHINA
 China Meteorological Administration, Beijing, CHINA
 Chinese Academy of Sciences, Beijing, CHINA
 Chinese Research Academy of Environmental Sciences, Beijing, CHINA
 Chulalongkorn University, Bangkok, THAILAND
 Department of Hydrology and Meteorology, Kathmandu, NEPAL
 Department of Meteorology, Colombo, SRI LANKA
 Institute for Global Change Research, Yokohama, JAPAN
 Hankuk University of Foreign Studies, Seoul, KOREA
 Hong Kong Polytechnique University, Hong Kong, CHINA
 Indian Institute of Tropical Meteorology, Pune, INDIA
 Institute for Global Change Research, Yokohama, JAPAN
 Institute for Atmospheric Physics, Beijing, CHINA
 International Centre for Integrated Mountain Development, Kathmandu, NEPAL.
 Korea University, Seoul, KOREA
 Korea Meteorological Administration, Seoul, KOREA
 Kyoto University, Kyoto, JAPAN
 Kwangju Institute of Science and Technology, Kwangju, KOREA
 Max Planck Institute for Chemistry, Mainz, GERMANY
 Meteorological Research Institute, Tsukuba, JAPAN
 Ministry of Environment and Construction, Malé, MALDIVES
 Ministry of Population and Environment, Kathmandu, NEPAL
 Ministry of Science and Technology, Beijing, CHINA
 NASA - Ames Research Center, California, USA
 NASA - Goddard Space Flight Center, Maryland, USA
 National Center for Atmospheric Research, Colorado, USA
 National Institute for Agro-Environmental Sciences, Tsukuba, JAPAN
 National Institute for Environmental Studies, Tsukuba, JAPAN
 National Physical Laboratory, New Delhi, INDIA
 National Natural Science Foundation of China, Beijing, CHINA
 National University of Computer and Emerging Sciences, Islamabad, PAKISTAN
 NOAA - Climate Modeling and Diagnostics Laboratory, Colorado, USA
 NOAA - Geophysical Fluid Dynamics Laboratory, Princeton University, New Jersey, USA
 Pacific Northwest National Laboratory, Washington, USA
 Peking University, Beijing, CHINA
 Physical Research Laboratory, Ahmedabad, INDIA
 Seoul National University, Seoul, KOREA
 State Environmental Protection Administration, Beijing, CHINA
 Stockholm University, Stockholm, SWEDEN
 Tribhuvan University, Kathmandu, NEPAL
 TERI: The Energy & Resources Institute, New Delhi, INDIA
 UNEP Regional Resource Centre for Asia and the Pacific, Bangkok, THAILAND
 University of Dhaka, Dhaka, BANGLADESH
 University of Iowa, Iowa, USA
 University of Miami, Florida, USA
 University of Peradeniya, Peradeniya, SRI LANKA
 University of Tokyo, Tokyo, JAPAN
 University of Wisconsin, Wisconsin, USA
 World Meteorological Organization, Geneva, SWITZERLAND

Presented by the ABC Science Secretariat
 Photos courtesy of H. V. Nguyen

Please direct questions and comments to:

Nicole Bezanson, Editor nicole@fiji.ucsd.edu

