



Project Atmospheric Brown Clouds (ABC)

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After more than a century of scientific studies on greenhouse gases (GHGs) and chlorofluorocarbons (CFCs), we have today a fair understanding of the 'global warming' and "ozone hole" issues. Many studies as well as policies are under implementation to better understand and address these issues.

Recent scientific studies have revealed a new atmospheric issue: Atmospheric Brown Clouds (ABC). The brown haze is caused by air pollution, mainly the sub-micron size aerosol particles, emitted from a wide range of anthropogenic and natural sources. Through the studies initiated under ABC project, scientists now have an overall view of the major sources and the global scale nature of the brown cloud problem.

The recent studies show that the aerosols in ABC reduce the amount of sunlight reaching the Earth's surface by as much as 10 to 15%, and enhance atmospheric solar heating by as much as 50%. Thus, ABCs, on the one hand, mask the greenhouse warming by the surface dimming, while on the other hand enhance the greenhouse warming of the atmosphere. While confirming that ABCs may have masked global warming by as much as 50% (see also IPCC, 2007), studies conducted by ABC scientists have led to new findings on regional climate changes:

- Slowing down of the monsoon circulation and reduction in monsoon rainfall.
- Increase strength and frequency of winter and spring time temperature inversion.
- Enhancing the greenhouse warming of the atmosphere thus contributing to glacier melting.

Preliminary assessment of the impacts identified potential direct and indirect consequences of the haze. These impacts include:

- Impacts on regional temperature, climate, precipitation patterns and water budgets, agriculture, and marine and terrestrial ecosystems.

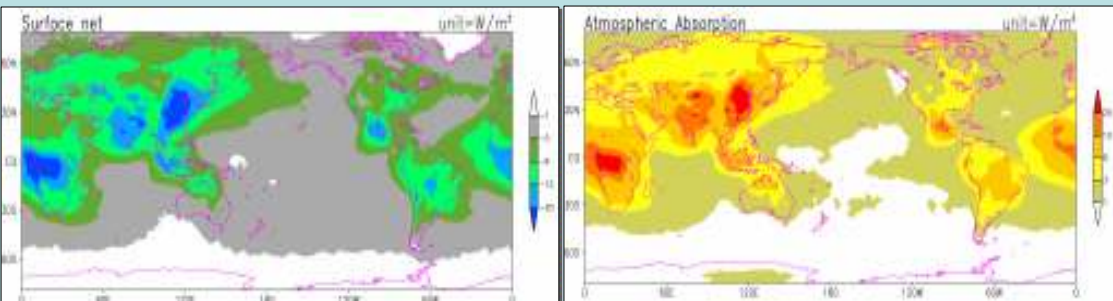
Climate-Agro-Economic crop modeling studies initiated by ABC scientists show that ABCs and GHGs together may have reduced rice production in Indian rain-fed states by as much as 15% since 1980s.

- Impacts on human health

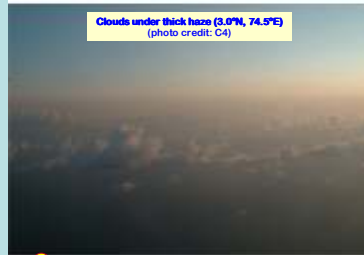
Global Distribution of ABC and Regional Hot Spots

By combining ABC surface observations with new satellite observations and chemistry-transport models, ABC scientists have produced global maps of ABCs with regional hotspots, their climate forcing and preliminary assessment of impacts on regional climate. The major regional hotspots are:

- Indo Gangetic Plain in South Asia (Northwest to northeast region extending from eastern Pakistan, across India to Bangladesh and Myanmar)
- East Asia (Eastern China, Thailand, Vietnam & Cambodia)
- Indonesian Region
- Southern Africa extending southwards from sub-Saharan Africa into Angola, Zambia and Zimbabwe
- The Amazon basin in South America



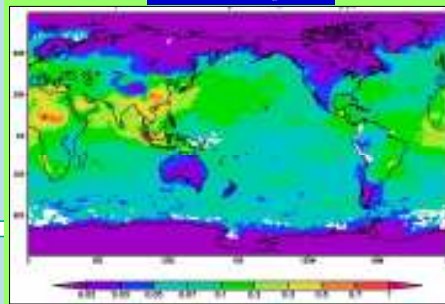
[Left Panel] Global extent of "global dimming" (reduction of solar radiation at the Earth's surface), and [Right Panel] atmospheric solar heating (due to absorption of solar radiation in the atmosphere) by atmospheric brown clouds for 2000 to 2003 developed from a combinations of satellite observations, surface network and aerosol transport models. [Ref: Ramanathan et al, ABC-special issue, *Journal of Geophysical Research*, 2007].



Potential Impacts on

- Climate Change
- Crop Production
- Glacial Melting
- Water Balance
- Human Health

Aerosol Loading



Simulated monthly mean distributions of Aerosol Optical Thickness (AOT550) for March 2005 in the clear sky condition, which indicates the aerosol loading (Source: T. Nakajima, 2007)

Project ABC

The aim of Project Atmospheric Brown Cloud (ABC) is to better understand the science and its impacts in order to provide a scientific basis for informed decision making. The project implementation includes:

- capacity building for scientific community through training and establishment of observatories;
- capacity building of network of institutions to carry out impact assessment studies, and
- policy level discussion on any action that may be needed to reduce and mitigate the impacts.

A preliminary assessment using the Indian Ocean Experiment (INDOEX) research was completed and the potential impacts caused by brown clouds on human health, food security and the water were disseminated in 2002. UNEP has facilitated an international science team to look into observation, science and impacts of ABC on regional climate, water budget, agriculture and human health. Capacity building activities were implemented through establishment of ABC observatories (over a dozen by 2006), either new or upgrading the existing sites, and training programs for Asian scientists. Through training and provision of equipments the stations are under national management.

ABC Observatories

- Maldives Climate Observatory- Hanimaadhoo (MCO-H)
- Maldives Climate Observatory- Gan (MCO-G)
- Indian Climate Observatory - Pune (ICO-P)
- Indian Climate Observatory - Kharagpur (ICO-K)
- Nepal Climate Observatory - Godavari (NCO-G)
- Nepal Climate Observatory - Pyramid (NCO-P)
- Thailand Climate Observatory - Phimai (TCO-P)
- Japan Climate observatory - Okinawa (JCO-O)
- Korea Climate Observatory - Gosan (KCO-G)
- Pacific Climate Observatory - Momote (PCO-MT)
- Pacific Climate Observatory - Midway (PCO-MW)
- Pacific Climate Observatory - Mauna Loa (PCO-ML)
- National Atmospheric and Climate Observatory - Trinidad Head (NACO-T).



ABC Impact Assessment

UNEP and ABC Science Team have assisted in the establishment of 3 teams consisting of distinguished scientists from the region and outside to conduct assessments of ABC impacts on human health, agriculture and water budget. Currently, following 3 lead regional institutions are coordinating the impact assessment studies:

- Indian Agriculture Research Institute (IARI), India [Agriculture]
- Nanyang Technological University (NTU), Singapore [Water Budgets]
- Chulabhorn Research Institute (CRI), Thailand [Human Health]

The Way Forward

With the successful establishment of a network of ABC observatories, establishment of ABC impact assessment groups and initiation of impact assessment studies, the project ABC has successfully completed its Phase I that has laid solid foundation for banking in to Phase II for long-term monitoring of ABC, expansion to other regional hotspots, comprehensive and scientific impact assessment studies, dissemination of findings and initiation of policy level dialogues.

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- Government of Italy
- Swedish International Development Cooperation Agency (Sida)
- National Oceanic and Atmospheric Administration, USA
- Department of Commerce, USA
- National Science Foundation (NSF), USA

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