Black Carbon e-Bulletin

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A Major Scientific Study on Black Carbon Intercomparison

Black Carbon (BC), which originates from incomplete combustion of fuel in such activities as fossil fuel combustion, biomass burning and bio-fuel burning for cooking and heating, is gaining more attention recently not only because it is now attributed as the second largest contributor to global warming (see the Science of BC and Climate change in the first issue of Black Carbon Bulletin) but also due to its impacts on human health and the great potential for implementation of control measures.

There is now global interest in BC data set. The paucity of observed BC data, in particular in many parts of Asia, that had limited our scientific understanding of the climate and health effects of BC, has been largely been addressed by creating unique observed BC and elemental carbon (EC) data sets acquired at many climate observatories in Asia under the Project Atmospheric Brown Cloud (ABC) of UNEP. The BC data set collected at 3 ABC sites in South Asia includes some interesting aspects. The BC-EC time series collected at Maldives climate observatory at Hanimaadhoo (MMCOH) is probably the only data set that contains long range transport of black and organic carbon from many parts of Asia, in particular South Asia with a long record of about 4 to 5 years. The site located at the northern end of the chain of islands receives BC transported over long range during the 5-6 months long dry season and mostly clean maritime air mainly from the southern hemisphere, with some BC from ships in the Southern Indian Ocean, during the summer monsoon time.

The data with about 3 years record from Nepal climate observatory-Godavari, located in the outskirt of Kathmandu valley, is a good indicator of mix of urban and rural effects whereas the data from Nepal climate observatory at Pyramid, which is located near the base camp area for Mt Everest and likely the highest altitude site for BC, has BC time series with about 3 years record that provides direct evidence of BC deposition on the Himalayan Glaciers.

These BC time series with about 4-5 years long record provide an unprecedented opportunities for the comparison of observed surface BC concentrations at three regionally unique locations with results simulated by climate models using either natural or both natural and anthropogenic emissions. Such intercomparion will help refine our understanding of the mechanisms of BC climate interactions, test and validate the performance of the climate models to reproduce intra-annual as well as inter-annual variability among others, and ultimately come up with a better quantification of the BC effects on climate change. As part of the Project ABC, scientists are participating in a major scientific study in which this unique BC-EC data set is used for model intercomparison and interpretation study that includes lead IPCC models and other climate models or chemical transport models. It is expected that the study will be an excellent scientific contribution to science of BC and climate change. <

Also in this Issue

Editorial: Seeing the whole picture

Achim Steiner, Executive Director, UNEP

The international community is working feverishly towards sealing a deal in Copenhagen, which is proving to be a challenge to all states, large or small, developed or developing. Much of the current discourse and positioning revolves around CO_2.

Given the scale of the climate challenge, it is important to construct a multi-pronged approach to finding a solution, one that opens up and explores all of the realistic policy avenues for addressing climate change. This means looking at factors other than CO_2 that contribute to climate change, which collectively amounts to almost 50 percent of global warming. A number of tracks can be taken to broaden the horizons of policy makers and negotiators, and the constituencies that can contribute towards solving the problem.

UNEP is engaging with its partners across all sectors to explore every possible means of combating climate change, which includes:

Publishing a Climate Change Science Compendium reviewing about 400 major scientific contributions to our understanding of Earth Systems and climate that have been released through peer-reviewed literature or from research institutions over the last three years.

Bringing together, drawing attention to, and further assessing the science on non carbon dioxide gases and black carbon. Significant progress has been made over the past 18 months, which allows policy makers to now contemplate a broader range of decisions on the basis of a more solid and rapidly improving science base.

Working with 30 environmental institutions and 250 scientists on researching atmospheric brown clouds (ABC's), which includes black carbon, and initiating a rapid integrated assessment of black carbon and tropospheric ozone.

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New Demands on Black Carbon Sciences

Prof. Teruyuki Nakajima, Center for Climate System Research, University of Tokyo
Chair, ABC-Asia Science Team

Black carbon (BC) aerosols play important roles in the earth's climate and environment. In Asia, emissions of BC and other types of aerosols from anthropogenic sources are especially significant and have given rise to atmospheric brown clouds or ABCs. Given Asia's dense population and expected future economic growth, accurate assessments of the effects of such emissions are indispensable to the region.

BC aerosol is a strong absorber of solar radiation. The resulting absorption of solar radiation causes heating in the atmosphere while cooling the surface, leading to a perturbation in the earth's radiation budget of over -10 Wm^{-2} in this region. Thus, the atmospheric vertical stability is changed. This effect is spatially inhomogeneous and can cause changes in atmospheric convection and large scale circulation reaching the tropics. Recent studies have proposed the potential for significant changes in monsoon circulation and summer time precipitation. The changes can be more than 1 mm day^{-1}, which can largely impact the global society, especially in Asia.

While scientific understanding of climate-aerosol interactions is now sufficiently advanced to support the promotion of emission reduction measures, the study of ABC impacts represents a new frontier. For example, high resolution models for accurately simulating ABC impacts on clouds and precipitation are under development. Recent studies suggest that hydrophobic BC can become hygroscopic through a complex chemical reaction during transportation. Also a mixture of BC and dust aerosols gives rise to uncertainties in the modeled aerosol optical and chemical properties. Continuing studies to find the accurate magnitude of various aerosol effects are recommended by the IPCC assessment report (AR4), UNEP ABC impact study report, and other assessment studies. Well-coordinated surface and in-situ measurements of aerosols and radiation budget, including airborne measurements, are key elements to making a breakthrough in addressing this problem. Also, there is a crucial need to develop accurate models for simulating aerosol effects on climate, hydrological cycle, agriculture, biomass, and human health. Such measurements and modeling efforts necessarily need international collaboration among various countries in Asia and other parts of the world, offering a very good opportunity for people to work together. While policy makers are focused on promoting mitigation measures, members of the scientific community throughout the world should conduct research and relevant studies to help in fine tuning pertinent policy responses. The ABC-Asia research community, therefore, likes to contribute to these research activities on ABC.

Benefits of Black Carbon Mitigation for Developing Countries

Bakary Kante, Division of Environmental Law and Conventions, UNEP

The focus of black carbon emissions reductions in developing countries can generally be divided into open burning sources (e.g. forests, crop residue, savannah) and 'contained' combustion sources (e.g. household cook stoves, diesel vehicles, coal-powered industry). The latter category is particularly important in the short term as elevated indoor exposures to these emissions, such as indoor fires, represent one of the largest sources of premature mortality and illness in developing countries, particularly among women and children. It is estimated that between 1.5 and 2 million premature deaths annually are attributed to exposure to indoor air pollution in developing countries[1], making this the fourth largest contributor to the total burden of disease after malnutrition, unsafe sex and poor sanitation[2]. Estimates also indicate that about 80% of total global exposure to airborne particulate matter occurs indoors in developing nations[1]. In the past several decades, interventions to replace such cooking and heating fires with 'improved stoves or those using cleaning burning fuels have been implemented and promoted as an efficient means to protect global public health. Now, these measures are also being suggested as cost-effective means to mitigate greenhouse gas emissions.

Given the sources of black carbon in developing countries, the challenge of designing realistic policies to reduce black carbon emissions is to develop effective technology modernisation and poverty reduction programmes. Technological advances have significantly mitigated black carbon emissions in industrial countries. Developing countries, on the other hand, often have been unable to afford the same technological advances, and, in turn, as their populations have grown, so have black carbon emissions. Controlling black carbon emissions in developing countries through, for example, the implementation of cleaner fuels, new cooking technologies, and changing crop management practices, is a potentially cost-effective means of postponing the effects of global warming, while at the same time improving the health and quality of life of many poor people.

A black carbon reduction strategy that includes global warming mitigation, technology transfer, and capacity building can produce successful results. A dedicated effort to expand programmes such as project Surya, featured in this bulletin, and to reduce emissions from the transport sector, would not only allow more time for creation of effective carbon dioxide-reduction regulations but would also have enormous public health and economic benefits. This provides an additional rationale – and potentially new funding – for putting black carbon mitigation programmes in place. However, the success of any black carbon programme will hinge upon strong technical and administrative capacity and sound programme design, as well as the use of local resources and sustained national-level attention.

UNEP is committed to collaborating with all stakeholders and forming partnerships to take definitive action on reducing black carbon emissions, particularly in developing countries where the health impacts are greatest. The landscape of actors who can contribute to solving this problem is broad and varied, from scientists to policy makers, to producers, farmers, households, etc. The wealth of knowledge that has been built up in science and technology needs to be shared, and cleaner technology needs to be made affordable and accessible. There is a need to reach out to all those who can make a difference and only by joining in partnership can real change be possible.<

1. Ezzati, M., and D. M. Kammen. 2002. "The health impacts of exposure to indoor air pollution from solid fuels in developing countries: knowledge, gaps, and data needs." Environmental Health Perspectives 110.11 (Nov 2002): 1057(12).
2. Ezzati, M. et al. (2002) "Selected major risk factors and global and regional burden of disease". Lancet, 360(9343):1347-1360.

PROJECT SURYA

Mitigation of Global and Regional Climate Change

Buying the planet time by reducing black carbon, methane and ozone

(Part I)

Nithya Ramanathan[1], I H Rehman[2], A. Kar[2], N. Bhatt[3], and V Ramanathan[3]

Project Surya aims to mitigate the regional and global impacts of anthropogenic climate change by immediately and demonstrably reducing atmospheric concentrations of black carbon, methane, and ozone. Together, black carbon (BC), methane, and ozone are responsible for 30% to 50% of the human effects on global warming. However, unlike CO_2 which lasts over a hundred years once released, these pollutants are short lived. Their effects on the atmospheric warming and glacier retreat will disappear within months (BC and ozone) to decades (methane) of reducing emissions, thus buying the planet much needed time to find solutions to mitigating the effects of CO_2. Ultimately Surya's aim is to steer the three billion people who depend on solid biofuels towards cleaner, locally available renewable energy sources.

Additionally, the major co-benefits of reducing these air pollutants will include immediate improvements in public health, agricultural productivity, and economic development for the rural populations in developing nations. Bringing together climate scientists, epidemiologists, computer scientists, energy technologists, economists and rural economic development experts, Project Surya takes an integrated approach to addressing four of the most pressing challenges facing Asia today: economic development, air pollution, climate change, and public health.

Focus

Surya's first focus is on the polluting solid biofuels (firewood, dung, crop residues) that millions of rural population are forced to burn for cooking, lighting, home heating, and small industry due to economic conditions. Activities will be implemented in phases. In its first phase, Project Surya will target three regions in rural India: one region in the Himalayas, one region in the Indo-Gangetic plains, and one region in South India for deployment. The Indo-Gangetic plains (IGP), extending eastwards from Pakistan, across India to Bangladesh, inhabited by 600 million, is one of the major source region for black carbon, CO_2 and other pollutants. Since it provides the southern boundary of the Hindu Kush-Himalayan (HKH) region, IGP is one

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Editorial ...

Focusing on black carbon and other climate changers is not an attempt to change the architecture of the negotiations, or to try and shoehorn new warming agents into the agreements. Rather, it is to help policy makers move quickly on developing a package of interventions that can be put on a fast track. This includes using existing governance structures and determining where they can help to reduce non-CO_2 emissions. For example, can we utilize a proven and universally supported regime like the Montreal Protocol and its Multilateral Fund to address the high global warming potential HFCs?

The science tells us that tipping points for abrupt climate change may be imminent, which makes speed of the essence. There are sectors such as transport and areas such as biofuels, where action can be taken now while the negotiations continue. UNEP is committed to examining how we can make progress in the short term by building on our existing strengths and drawing from tried, tested and well supported mechanisms. This includes considering the timing of interventions and how they can be applied to sectors and areas above and beyond existing measures.

Echoing the words of the UN Secretary General at the Climate Change Summit that took place in New York on 23 September 2009, "there is little time left. The opportunity and responsibility to avoid catastrophic climate change is in [our] hands."

It would be remiss if we did not use everything we have in our arsenal to attack the problem. UNEP is deploying its resources to assist governments access the best science available on the full suite of options to combat climate change.<

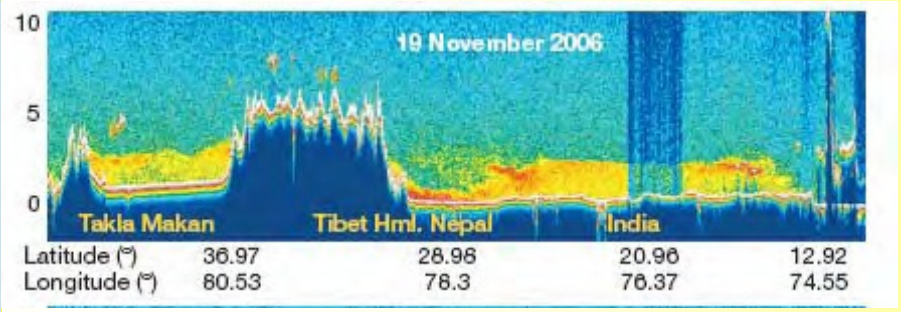
SCIENCE-POLICY CONSULTATION ON NON-CO_2 EMISSIONS

A science - policy consultation on non-CO_2 emissions was held at the National Academy of Sciences (NAS) in Washington DC, US on 25 September 2009. The consultation, held under the auspices of UNEP, was attended by high level participants representing the scientific and policy communities. The objectives of the consultation included:

- to broaden understanding of the current state of the science regarding non-CO_2 emissions that contribute to climate change with special focus on Black Carbon (BC) and Hydrofluorocarbons (HFCs).
- to commence a dialogue on an appropriate policy response, particularly in the context of climate change mitigation and adaptation.

Recognizing the need for fast action, the consultation derived key recommendations for the development of a fast action work programme for addressing the non-CO_2 emissions. <

Project Surya ...



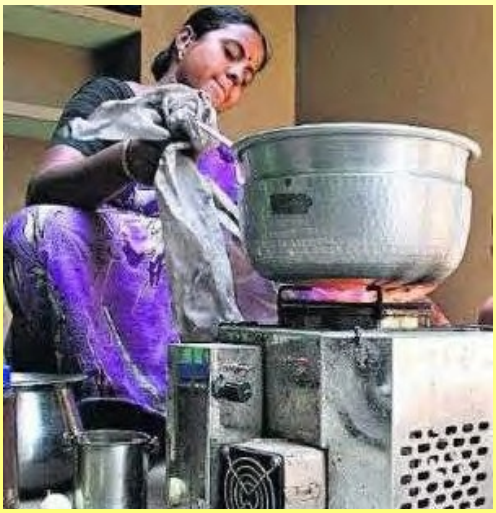
CALIPSO data for BC surrounding Himalayas

of the major pollution sources for the effects of black carbon on the fast retreat of the HKH glaciers. Surya will provide sustainable, effective, incentive-based plans to enable five to ten thousand households in each region to switch to cleaner-burning technologies such as solar lamps, biogas plants, efficient stove technologies, and solar cookers.

Unprecedented Data Collection

What distinguishes Project Surya from numerous other cleaner-cooking projects is its scope and evaluation. Surya's multi-disciplinary team will undertake the most comprehensive and rigorous scientific evaluation to date on the efficacy of reducing biomass-fueled cooking on climate warming, air pollution, and health.

Surya's study methodology is unique because it aims to collect high quality, reliable data at every level: from the individual household, to the village, to the regional impacts of the project intervention. Household data will be collected via cutting-edge sensor technologies and analytics installed in mobile phones distributed to participating households. These mobile phones will measure individual reductions in exposure to pollutants as well as adherence to the intervention in a distributed and scalable fashion that improves on traditional data collection technologies. Instrumented towers installed in each region will collect climate-related metrics at the village level including concentrations of BC, carbon monoxide, and ozone, and will measure the resulting change in the solar heating of the air and the ground. Finally, these data will be combined with the most advanced data from A-Train NASA satellite (http://aura.gsfc.nasa.gov/instruments/omi.html) to measure the regional heating effects and probable cooling effect of other particles emitted when solid biofuels are burned.



BP Oorja Stove: Smokeless Biomass Stove

Documentation of the Impacts of Intervention

The evaluation of black carbon effects on heating will take two years. During year one, background data will be collected without intervention. Deployment of new technologies will commence at the end of year one. Conceptually, Surya will create a BC hole in the intervention region within weeks of introducing the energy-efficient technologies. In order to separate the 'signal' from contamination smoke from surrounding regions, the control village and the surrounding villages will be monitored using satellite instruments. The height of the BC cloud, absorption of sunlight by the cloud, ozone, nitrogen dioxide and sulfur dioxide, will be used in conjunction with meso scale models to quantify the transport of smoke and air pollutants from areas outside the region of intervention. The analyzed data will be used as input to regional climate models to estimate the reduction in the global warming potential of soot.

Locally Relevant Goals and Capacity Building

At the local level Surya targets cooking with solid biomass fuels to reduce BC, primarily because reduction in smoke from cooking is expected to have major co-benefits like improved health of women and children due to reduced exposure to indoor air pollution. At the regional level Surya will mitigate the retreat of the glaciers and snow packs of the Hindu Kush-Himalayan region.

The specific aims of the project are:

- Document the impact of using kerosene lamps for lighting applications and using mud stoves with locally available unprocessed biomass for cooking applications (Business as Usual-BAU scenario) on local environment (outdoor and indoor air quality in terms of soot, particulate matter, carbon monoxide and carbon dioxide emissions) of a sample population as the study baseline.
- Replace above mentioned polluting lighting and cooking technologies by disseminating clean technologies like solar lanterns and energy efficient improved cooking (and processed fuel) technology to a sample population and ensure sustained voluntary usage.
- Document the impact of using solar lanterns for lighting applications and energy efficient improved cookers (and processed fuel) for cooking applications to undertake a comparative assessment of the local environment.<

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To be continued in the next issue

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