



Atmospheric Brown Clouds: implications for climate and health

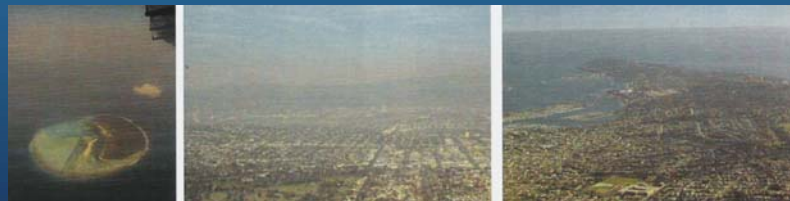
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Outline

- What are ABC's
- Project ABC
- ABC Monitoring
- First Assessment Report
- Potential Impacts on Health
- Conclusions

What are ABC's?

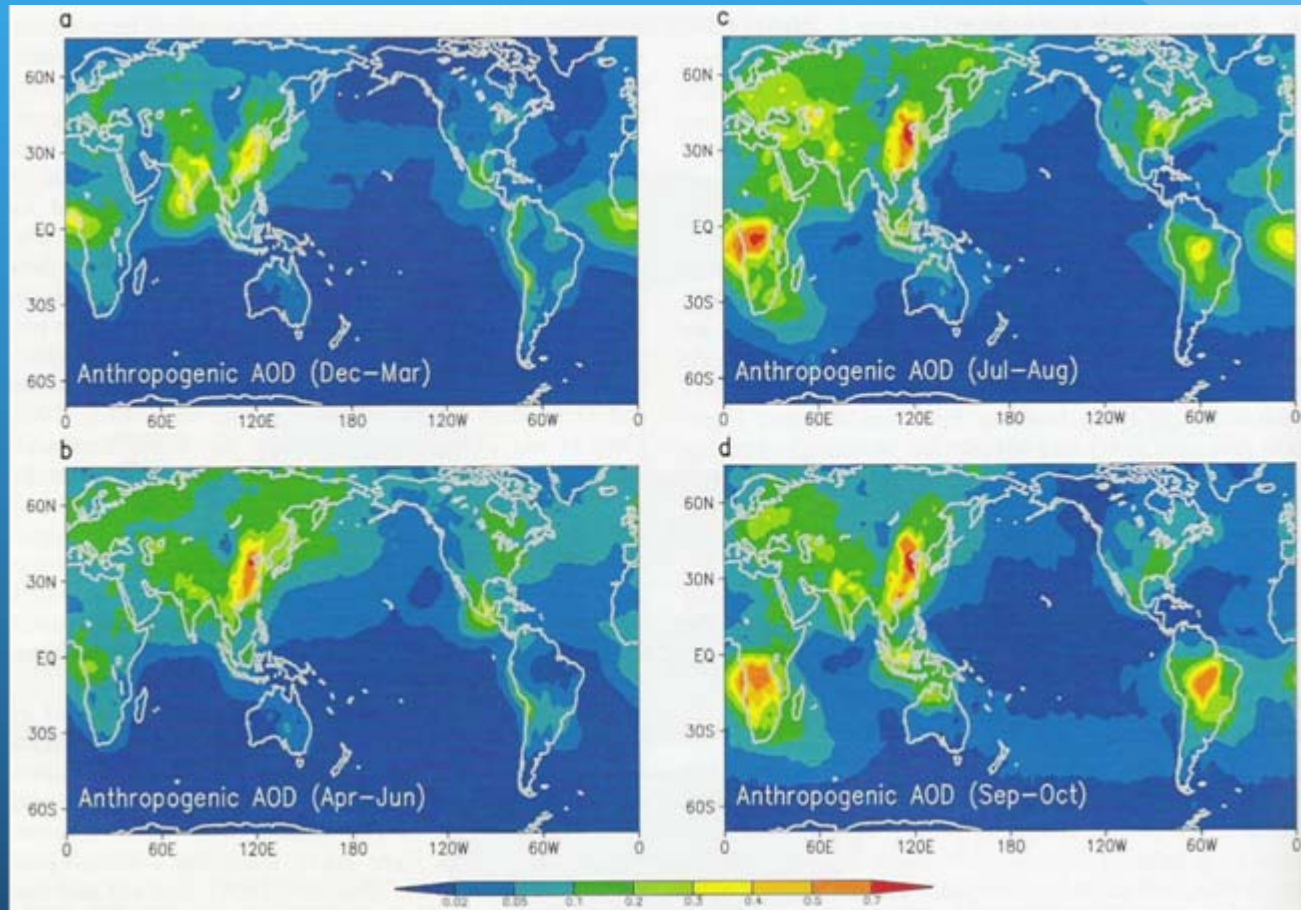
- ABCs are regional scale plumes of air pollution in the form of widespread layers of brownish haze containing particles
- ABCs start as indoor and outdoor air pollution consisting of primary aerosols and pollutant gases, e.g. nitrogen oxides (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), and ammonia (NH_3)
- Widespread plumes resulting from the combustion of biofuels from indoors, biomass burning outdoors and fossil fuels, are found in all densely inhabited regions and oceanic regions downwind of populated continents



ABC Hotspots

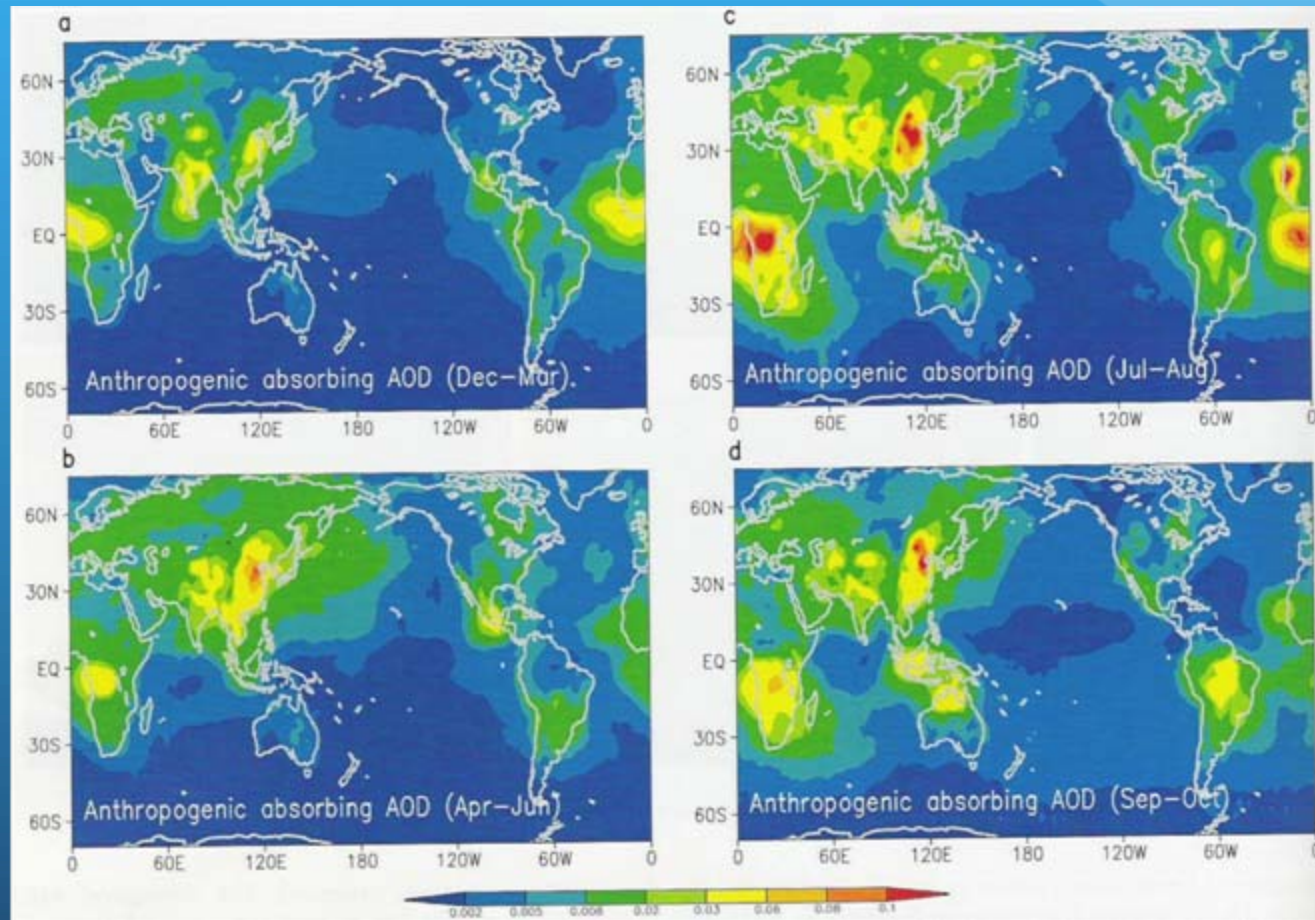
- Five regional ABC hotspots (i.e. regions where mean anthropogenic aerosol optical depth, AOD, exceeds 0.3 and absorbing AOD > 0.03) around the world have been identified: (i) East Asia, (ii) Indo-Gangetic Plain in South Asia, (iii) Indonesia Region, (iv) Southern Africa, and (v) the Amazon Basin.
- Thirteen mega-city hotspots have been identified: Bangkok, Beijing, Cairo, Dhaka, Karachi, Kolkata, Lagos, Mumbai, New Delhi, Seoul, Shanghai, Shenzhen and Tehran.

ABC Hotspots - AOD



Ramanathan et al, 2007

ABC Hotspots - absorbing AOD



Ramanathan et al, 2007

ABC Potential Impacts

- ABC components, including soot, sulphates and other aerosol components, can reduce the amount of solar radiation reaching the earth's surface, enhance atmospheric solar heating and change cloud properties, and thus are major threats to climate, as well as water and food security
- ABCs > Climate > Water > Agriculture > Health

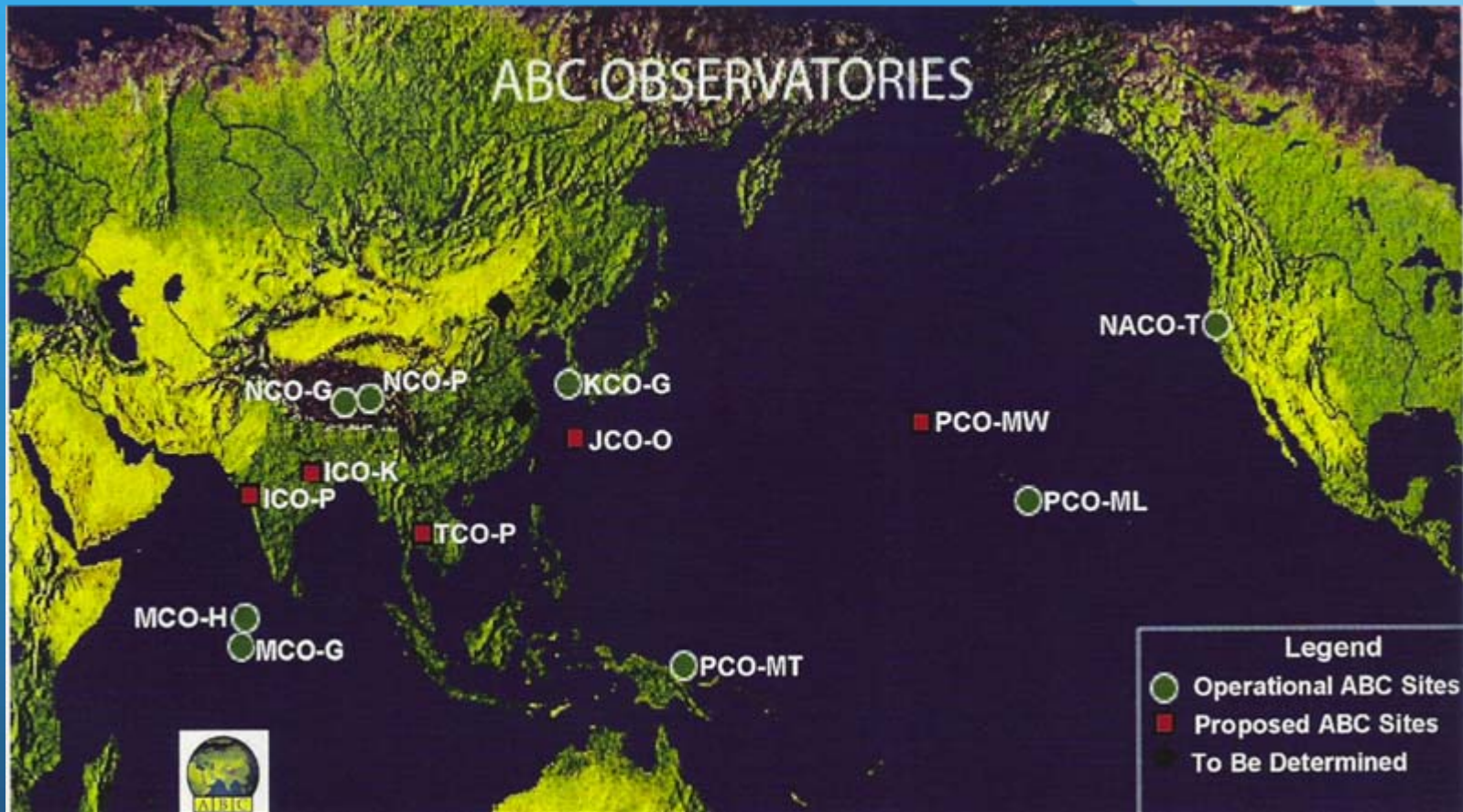
Project ABC

- The United Nations Environment Programme (UNEP) and the Center for Clouds, Chemistry and Climate (C⁴) launched the international Atmospheric Brown Cloud (ABC) project in 2002 to characterize the nature of south Asian aerosols and their impacts on the environment (UNEP and C⁴, 2002)
- The Indian Ocean Experiment (INDOEX) between 1998-1999 was one of the first studies to document the existence of haze over the Indian subcontinent and to quantify its impacts on solar radiation budget (Ramanathan et al, 2001)

ABC project components

- ABC Observatories & capacity building - training and establishing observatories
- Impact assessments - capacity building of network of institutions to carry out impact assessment studies
- Awareness, mitigation and dissemination - policy-level discussions on actions needed to reduce and mitigate the impacts

ABC Monitoring

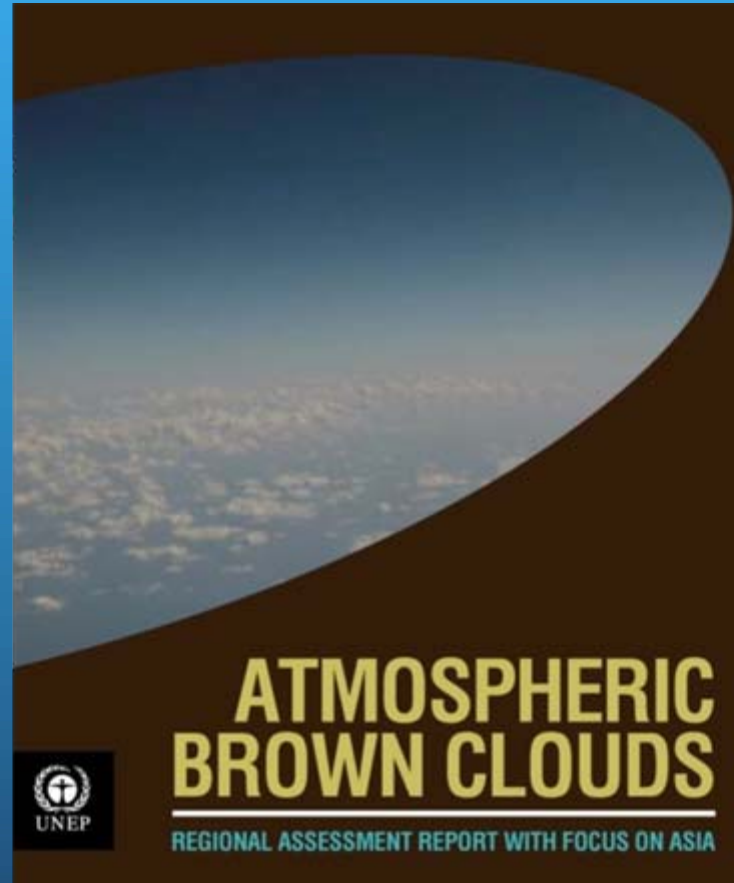


Ramanathan et al, 2007

Impact assessments

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

First Impact Assessment Report (2006)



<http://www.rrcap.unep.org/abc/impact/index.cfm>

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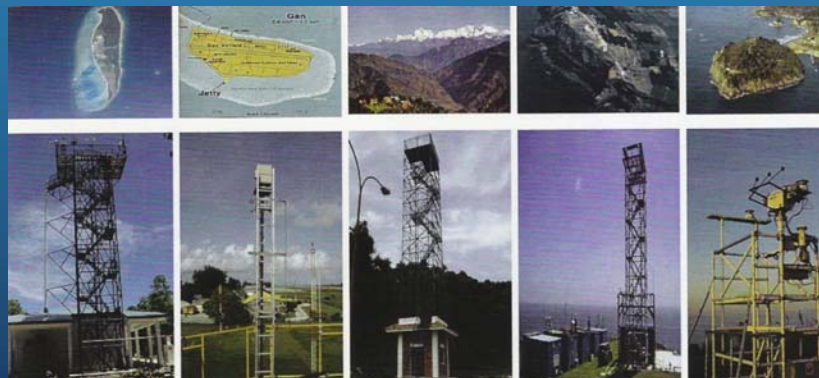
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Topics covered

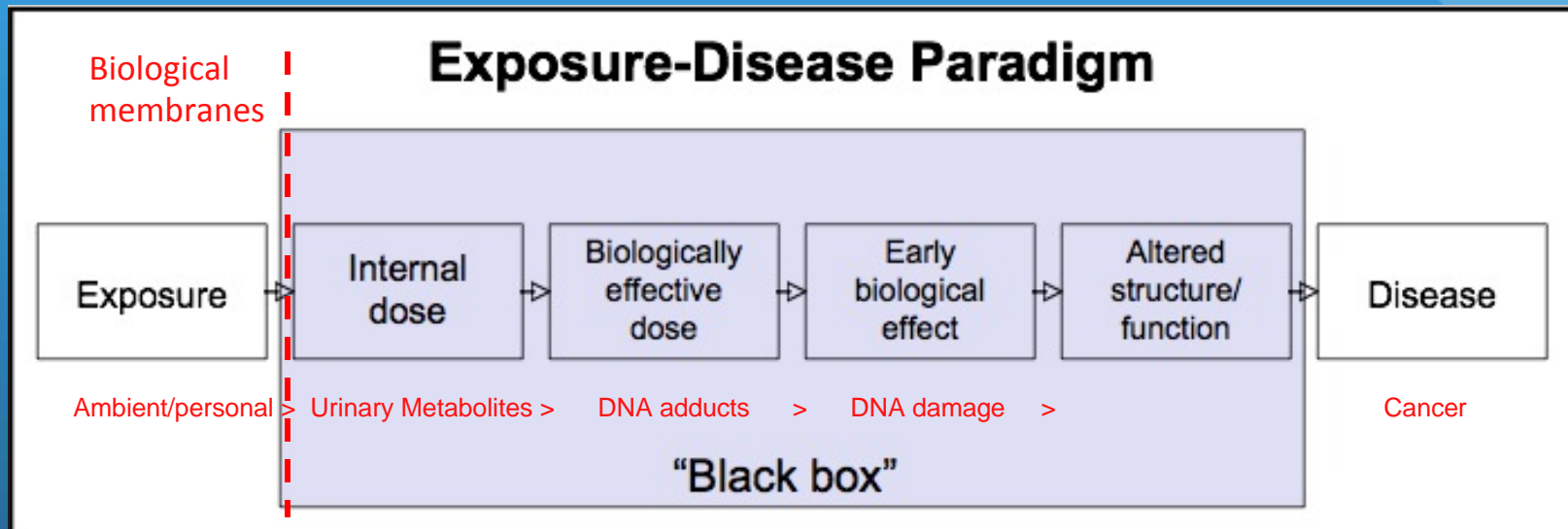
1. The Phenomenon, Human Health, Well-being and Welfare
2. Assessing Exposures
3. Insights from Epidemiology
4. Toxicology
5. Quantifying Health Impacts
6. Economic Consequences
7. Interface of Science and Policy
8. Recommendations

Monitoring - a health perspective

- Parameters of interest from a climate perspective and a health perspective are not the same
- Ambient levels and those that cross biological membranes, reach target tissues and exert their toxic effects are not the same
- In moving forward, it is key to assessment of health impacts for monitoring efforts to cover additional parameters of relevance to health



Implications for Health - exposures



Actual exposures, including extent of exposures, in human populations must be established – this is different from ambient exposure levels

Pollutant	Effects - epidemiology
PM ₁₀ (forest fires, wildfires, sugar cane burning, dust storms)	Increased mortality (infants and elderly); Increased hospital admissions; respiratory symptoms; school absenteeism; increased hospital admissions due to asthma; reduced lung function
PM _{2.5}	All-cause mortality, cardiopulmonary effects, lung cancer
PM	Low birth weight, pre-term delivery
Biomass combustion (PM)	Lung cancer; acute respiratory infections
Coal smoke	Lung cancer
SO ₂	Increased daily mortality and hospital admissions
SO ₄ ²⁻	Mortality (cardiovascular)

Pollutants	Effects - toxicology
PM ₁₀	Cardiac effects in rodents and dogs (metallic elements and sulphates)
Concentrated ambient PM	Atherosclerotic lesions and other vascular changes in mice
Coal fly ash (PM + Fe/As/Ni)	Acute pulmonary effects, inflammation, oxidative stress, increased susceptibility to bacterial infections, lung tumors
Wood smoke	Effects on inflammation, coagulation and lipid peroxidation in controlled human experiments; reduced lung bacterial clearance and decreased lung function in animals; extracts mutagenic in bacterial systems
PM from wood smoke	Increased cardiovascular morbidity and mortality
NO ₂	Cardiac effects (heart rate) and pulmonary inflammation in mice at very high concentrations
PM _{0.1} (ultrafine)	Most potent for lung inflammation and macrophage death in culture

HISG ABC Health Summary

- There is currently insufficient actual ABC exposure data in human populations
- Epidemiological studies that have addressed direct health effects of ABC-relevant pollution sources, e.g. wildfires, indoor biomass and coal smoke, and dust events have documented a variety of acute and chronic health effects, including premature deaths, hospital admissions and chronic respiratory disease
- Available information on health effects of fine particles suggest ABC exposure is very likely associated with significant adverse health effects

HISG ABC Health Summary (cont)

- Toxicological studies with ABC-relevant pollutants (wood smoke, diesel exhaust, PM) associate them with cardiovascular and respiratory disease, cancer and reproductive & developmental alterations

Conclusions

- As we move forward, health-related information specific to ABCs is required (exposures, toxicology & epidemiology)
- Exposure assessment studies in populations affected by ABCs is required - this is important for both epidemiological and toxicological studies
- For epidemiology studies, there is a need to identify populations that are clearly different in their ABC exposure
 - Exposure to ABCs is difficult to isolate from exposure to other forms of air pollution indoors and outdoors and, therefore, future epidemiology studies need to control for these other forms of air pollution
 - Comparing the health status of such populations would provide powerful evidence of the direct health effects of ABC exposure

Conclusions (cont)

- As epidemiology studies will be difficult to conduct (because such populations will be hard to identify), it is recommended that long-term, low dose animal studies be conducted
 - Such studies would add powerful experimental evidence for the adverse health effects of ABCs
- A careful characterization of “real world” exposure levels is needed to ensure relevancy of toxicological (animal) studies
- Toxicology studies should utilize a “laboratory-synthesized model mixture” of combustion products that closely reflects the chemistry of ABCs

Conclusions (cont)

- Using sensitive animal models, inhalation studies should examine the effect of ABC on susceptibility to infectious agents that are relevant to those causing disease in developing nations (e.g. pneumonia, TB)
- Susceptibility studies should utilize compromised animal models, as well as evaluate the role of gender and age (juvenile to adult)
- Studies should examine the effect of prenatal exposure to “modeled” ABC effluents, individual ABC components, and biomass smoke
 - determine fetal susceptibility and ABC-induced effects on pregnant women and their unborn fetus

ABC Project Secretariats

- ABC Secretariat

United Nations Environment Programme

Regional Office for Asia & the Pacific

www.rrcap.unep.org/abc

- Science Secretariat

Center for Cloud, Chemistry & Climate (C⁴)

Scripps Institution of Oceanography, UC San Diego

www-abc-asia.ucsc.edu

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- United Nations Environment Programme and the Center for Clouds, Chemistry and Climate (UNEP and C⁴) (2002) The Asian Brown Cloud: Climate and Other Environmental Impacts, U.N. Environ. Programme, Nairobi, Kenya.
- <http://www.rrcap.unep.org/abc/>

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Thank you