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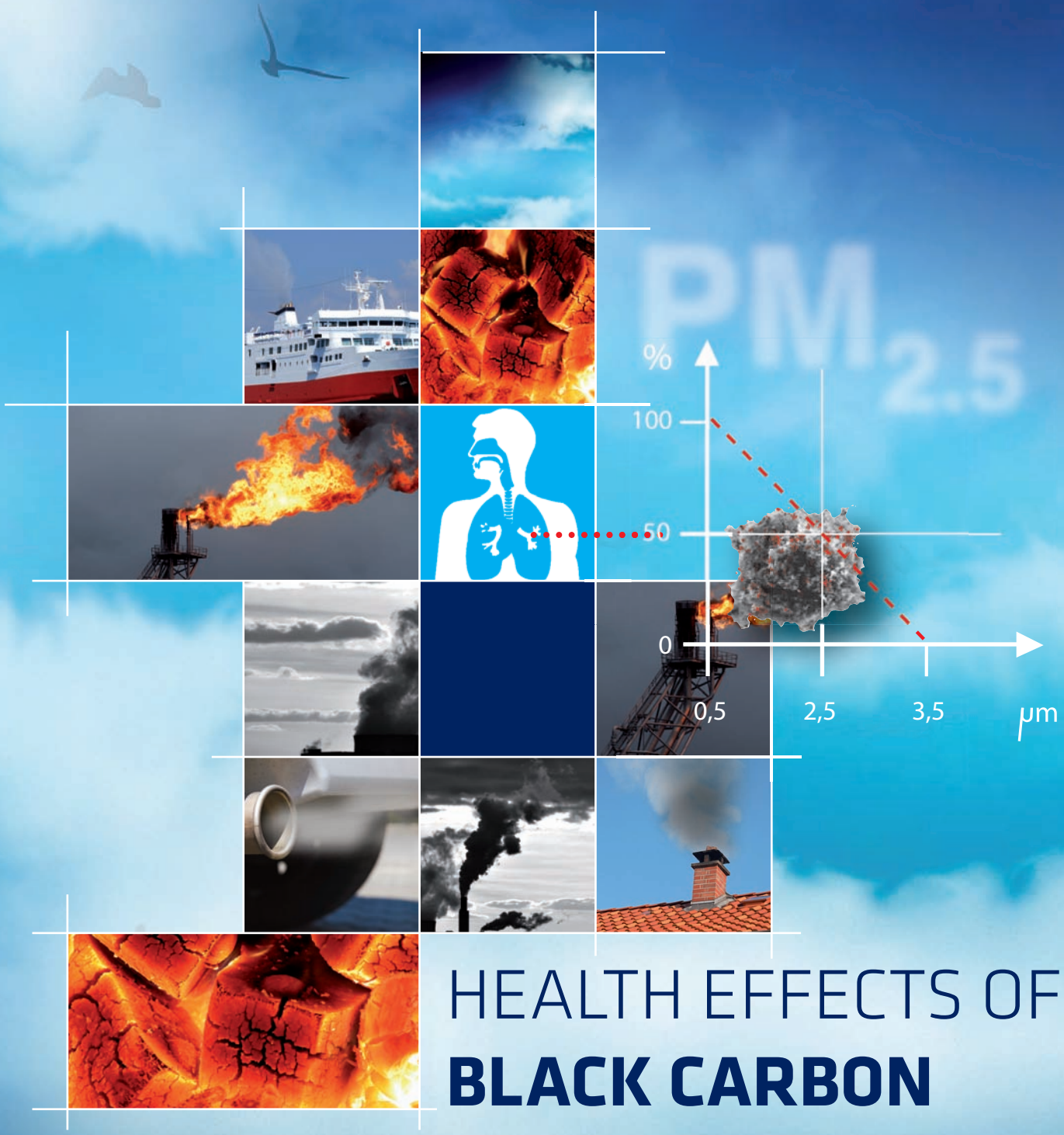

HEALTH EFFECTS OF **BLACK CARBON**

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Health effects of black carbon

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ABSTRACT

This report presents the results of a systematic review of evidence of the health effects of black carbon (BC). Short-term epidemiological studies provide sufficient evidence of an association of daily variations in BC concentrations with short-term changes in health (all-cause and cardiovascular mortality, and cardiopulmonary hospital admissions). Cohort studies provide sufficient evidence of associations of all-cause and cardiopulmonary mortality with long-term average BC exposure. Studies of short-term health effects suggest that BC is a better indicator of harmful particulate substances from combustion sources (especially traffic) than undifferentiated particulate matter (PM) mass, but the evidence for the relative strength of association from long-term studies is inconclusive. The review of the results of all available toxicological studies suggested that BC may not be a major directly toxic component of fine PM, but it may operate as a universal carrier of a wide variety of chemicals of varying toxicity to the lungs, the body's major defence cells and possibly the systemic blood circulation. A reduction in exposure to $PM_{2.5}$ containing BC and other combustion-related PM material for which BC is an indirect indicator should lead to a reduction in the health effects associated with PM.

Keywords

AIR POLLUTION – adverse effects
SOOT – toxicity
INHALATION EXPOSURE – adverse effects
PARTICULATE MATTER – analysis
RISK ASSESSMENT

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Convention on Long-range Transboundary Air Pollution

Abbreviations

Abs	absorbance
BC	black carbon
BCP	black carbon particles
BS	black smoke
CVD	cardiovascular disease
DE	diesel engine exhaust
EC	elemental carbon
IQR	inter-quartile range
NIOSH	National Institute for Occupational Safety and Health
OC	organic carbon
PAH	polycyclic aromatic hydrocarbons
PM	particulate matter
POM	particulate organic matter
RSS	rice-straw smoke
RR	relative risk
TOR	thermal optical reflectance
TOT	thermal optical transmittance
UFP	ultrafine particles

Executive summary[1]

Following decision 2010/2 of the Executive Body for the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/106/Add.1, para 8(b)(i)), the Task Force on Health Aspects of Air Pollution working under the Convention conducted an assessment of the health effects of black carbon (BC) as a component of fine particulate matter ($PM_{2.5}$). The Task Force's discussion focused on formulating the conclusions presented below, on the basis of the working papers prepared for it and comments received from external reviewers.

BC is an operationally defined term which describes carbon as measured by light absorption. As such, it is not the same as elemental carbon (EC), which is usually monitored with thermal-optical methods. Current measurement methods for BC and EC need to be standardized so as to facilitate comparison between the results of various studies. The main sources of BC are combustion engines (especially diesel), residential burning of wood and coal, power stations using heavy oil or coal, field burning of agricultural wastes, as well as forest and vegetation fires. Consequently, BC is a universal indicator of a variable mixture of particulate material from a large variety of combustion sources and, when measured in the atmosphere, it is always associated with other substances from combustion sources, such as organic compounds. The spatial variation of BC is greater than that of $PM_{2.5}$. Although, in general, ambient measurements or model estimates of BC reflect personal exposures reasonably well and with similar precision as for $PM_{2.5}$, the differences in exposure assessment errors may vary between studies and possibly affect estimates of risk.

The systematic review of the available time-series studies, as well as information from panel studies, provides sufficient evidence of an association of short-term (daily) variations in BC concentrations with short-term changes in health (all-cause and cardiovascular mortality, and cardiopulmonary hospital admissions). Cohort studies provide sufficient evidence of associations of all-cause and cardiopulmonary mortality with long-term average BC exposure.

Health outcomes associated with exposure to $PM_{2.5}$ or thoracic particles (PM_{10}) are usually also associated with BC (and vice versa) in the epidemiological studies reviewed. Effects estimates (from both short- and long-term studies) are much higher for BC compared to PM_{10} and $PM_{2.5}$ when the particulate measures are expressed per unit of mass concentration ($\mu g/m^3$). Effect estimates are, however, generally similar per inter-quartile range in pollutant levels. Studies of short-term health effects show that the associations with BC are more robust than those with