

Black Carbon (BC) and Co-pollutants from Incomplete Combustion

Black carbon particles are formed from the incomplete combustion of biomass and fossil fuels. It is a powerful climate forcer and dangerous air pollutant.

EMISSIONS

Main BC-rich sources by region and sector (2005)

Latin America and Caribbean | N. America and Europe | Africa | S. W. and Central Asia | NE, SE Asia and Pacific

PRIMARY BLACK CARBON-RICH SOURCES

BC is always emitted with co-pollutant particles, some of which have a cooling effect on climate. The ratio of BC to co-pollutants varies by source and determines if a measure has a **net warming** or **net cooling** effect.

- Resident biofuel cooking and heating
- Resident coal cooking and heating
- On-road diesel engines
- Off-road diesel engines
- Industrial coal and brick kilns
- Open burning agricultural fields

LIFETIME IN ATMOSPHERE

Days

IMPACTS

Suspended in the atmosphere, BC particles contribute to **global warming** by absorbing energy and converting it to heat

BC is a dangerous local air pollutant which can also be **transported across the globe**

Clean clouds reflect sunlight | BC scavenged by clouds | Sooty clouds absorb light | Changes in cloud and rain patterns

BC harms human health | Dims light coming to the Earth's surface | BC impacts ecosystems | Clean snow and ice reflect sunlight | BC deposits on snow and ice | Sooty mountains absorb light | Increases melting

WHAT IS BLACK CARBON?

Black carbon is a potent climate-warming component of particulate matter formed by the incomplete combustion of fossil fuels, wood and other fuels. Complete combustion would turn all carbon in the fuel into carbon dioxide (CO₂), but combustion is never complete and CO₂, carbon



monoxide, volatile organic compounds, and organic carbon and black carbon particles are all formed in the process. The complex mixture of particulate matter resulting from incomplete combustion is often referred to as soot.

Black carbon is a short-lived climate pollutant with a lifetime of only days to weeks after release in the atmosphere. During this short period of time, black carbon can have significant direct and indirect impacts on the climate, glacial regions, agriculture and human health.

Several studies have demonstrated that measures to prevent black carbon emissions can reduce near-term warming of the climate, increase crop yields and prevent premature deaths.

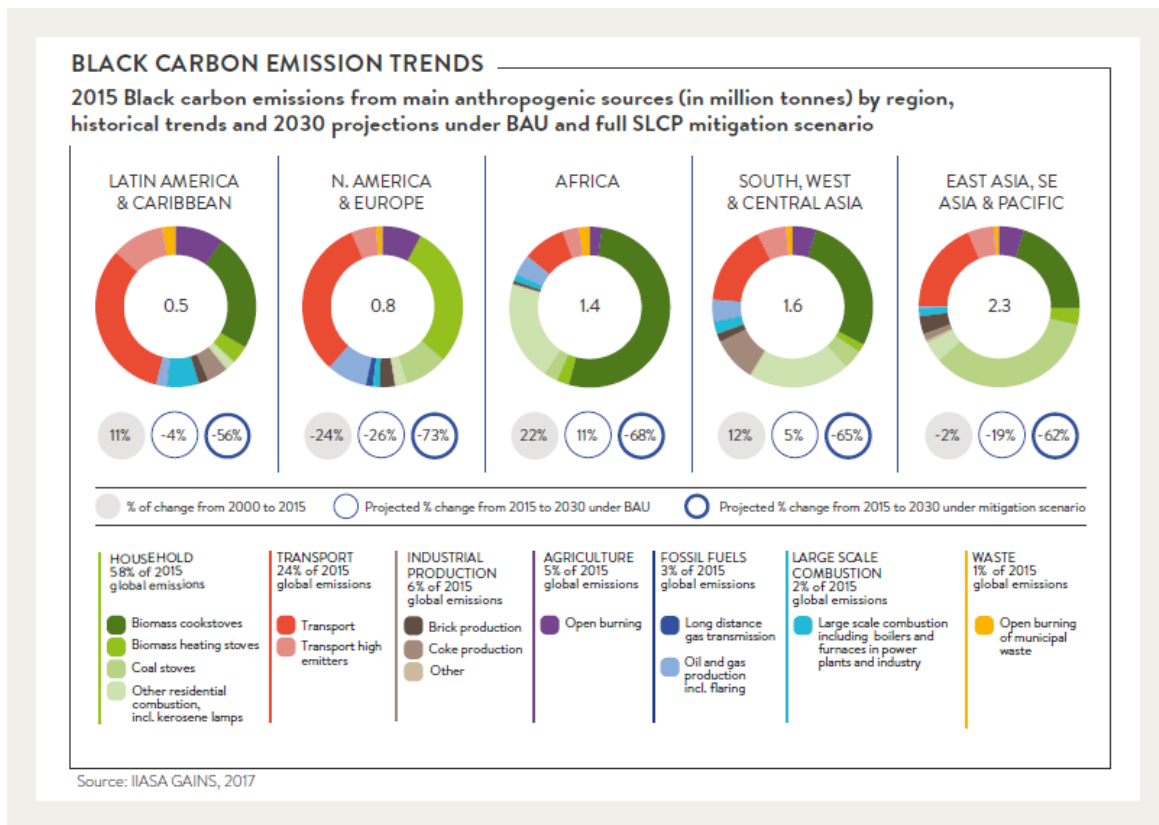
KEY FIGURES

460-1,500x	4-12 days	6.6 million tonnes	58%
Black carbon has a warming impact on climate 460-1,500 times stronger than CO ₂ per unit of mass	The average atmospheric lifetime of black carbon particles is 4-12 days	About 6.6 million tonnes of black carbon were emitted in 2015	Household cooking and heating account for 58% of global black carbon emissions

PRIMARY SOURCES OF BLACK CARBON EMISSIONS

Black carbon emissions have been decreasing over the past decades in many developed countries due to stricter air quality regulations. By contrast, emissions are increasing rapidly in many developing countries where air quality

is not regulated. As the result of open biomass burning and residential solid fuel combustion, Asia, Africa and Latin America contribute approximately 88% of global black carbon emissions.



Black carbon is always co-emitted with other particles and gases, some of which have a cooling effect on the climate. The type and quantity of co-pollutants differs according to the source. Sources that release a high ratio of warming to cooling pollutants represent the most promising targets for mitigation and achieving climate and health benefits in the near term.

BLACK CARBON IMPACTS

CLIMATE IMPACTS

Black carbon is an important contributor to warming because it is very effective at absorbing light and heating its surroundings. Per unit of mass, black carbon has a warming impact on climate that is 460-1,500 times

stronger than CO₂.

When suspended in the atmosphere, black carbon contributes to warming by converting incoming solar radiation to heat. It also influences cloud formation and impacts regional circulation and rainfall patterns.

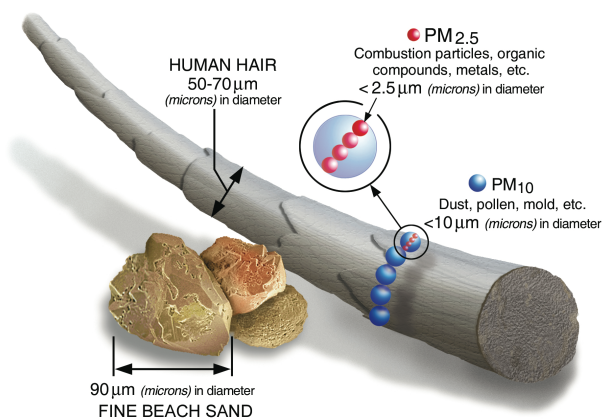


When deposited on ice and snow, black carbon and co-emitted particles reduce surface albedo (the ability to reflect sunlight) and heat the surface. The Arctic and glaciated regions such as the Himalayas are particularly vulnerable to melting as a result.

HEALTH IMPACTS

Black carbon and its co-pollutants are key components of fine particulate matter (PM_{2.5}) air pollution, the leading environmental cause of poor health and premature deaths.

At 2.5 micrometres or smaller in diameter, these particles are, many times smaller than a grain of table salt, which allows them to penetrate into the deepest regions of the lungs and facilitate the transport of toxic compounds into the bloodstream.



PM_{2.5} has been linked to a number of health impacts including premature death in adults with heart and lung disease, strokes, heart attacks, chronic respiratory disease such as bronchitis, aggravated asthma and other cardio-respiratory symptoms. It is also responsible for premature deaths of children from acute lower respiratory infections such as pneumonia.

Each year, an estimated 7 million premature deaths are attributed to household and ambient (outdoor) PM2.5 air pollution.

IMPACTS ON VEGETATION AND ECOSYSTEMS

Black carbon can affect the health of ecosystems in several ways: by depositing on plant leaves and increasing their temperature, dimming sunlight that reaches the earth, and modifying rainfall patterns.

Changing rain patterns can have far-reaching consequences for both ecosystems and human livelihoods, for example by disrupting monsoons, which are critical for agriculture in large parts of Asia and Africa.

SOLUTIONS

Black carbon's short atmospheric lifetime, combined with its strong warming potential, means that targeted strategies to reduce emissions can provide climate and health benefits within a relatively short period of time.

The Coalition supports implementation of control measures that, if globally implemented by 2030, could reduce global black carbon emissions by as much as 80% ([UNEP & WMO 2011](#)). Several of these emission reductions could be achieved with net cost savings. Adopting these measures would have major positive co-benefits for public health, especially in the developing world.

BLACK CARBON - 80% emissions reduction potential globally by 2030

HOUSEHOLD ENERGY

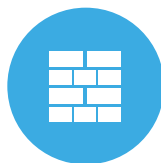
- Replace traditional cooking to clean burning modern fuel cookstoves
- Replace traditional cooking and heating with clean-burning biomass stoves
- Eliminate kerosene lamps

	<ul style="list-style-type: none">▪ Replace lump coal with coal briquettes for cooking and heating▪ Replace wood stove and burners with pellet stoves and boilers
INDUSTRIAL PRODUCTION	<ul style="list-style-type: none">▪ Modernize traditional brick kilns to vertical shaft brick kilns▪ Modernize coke ovens to recovery ovens
TRANSPORT	<ul style="list-style-type: none">▪ Use diesel particular filters for road and off-road vehicles▪ Fast transition to Euro VI/6 vehicles and soot-free buses and trucks▪ Eliminate high-emitting diesel vehicles
AGRICULTURE	<ul style="list-style-type: none">▪ Ban open-field burning of agricultural waste
FOSSIL FUELS	<ul style="list-style-type: none">▪ Capture and improve oil flaring and gas production
WASTE MANAGEMENT	<ul style="list-style-type: none">▪ Ban open burning of municipal waste

INITIATIVES



AGRICULTURE



BRICKS



EFFICIENT COOLING



HEAVY-DUTY VEHICLES



HOUSEHOLD ENERGY



OIL AND GAS



WASTE



WASTE



AGRICULTURE



ASSESSMENTS



FINANCE



HEALTH



SNAP



SNAP

RELATED RESOURCES

2018 | Scientific Advisory Panel Updates
Climate and Clean Air Coalition (CCAC)

2018 Annual Science Update - Black Carbon Briefing Report

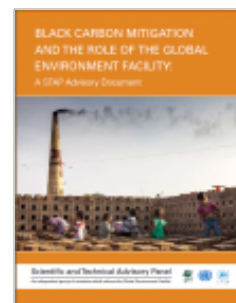
Several publications were released in recent years that have provided insights and



2015 | Reports, Case Studies & Assessments
Global Environment Facility's Scientific and Technical Advisory Panel

Black Carbon Mitigation and the Role of the Global Environment Facility

Black Carbon Mitigation and the Role of the Global



better understanding of short-lived climate pollutant (SLCP) science, including on their emissions, inventories...

Environment Facility, was produced by the Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility (GEF). It...

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MULTIMEDIA
