

A Quick Look at Black Carbon



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Black Carbon

- What is it?
- What does it do?
- What can we do about it?

What is Black Carbon?

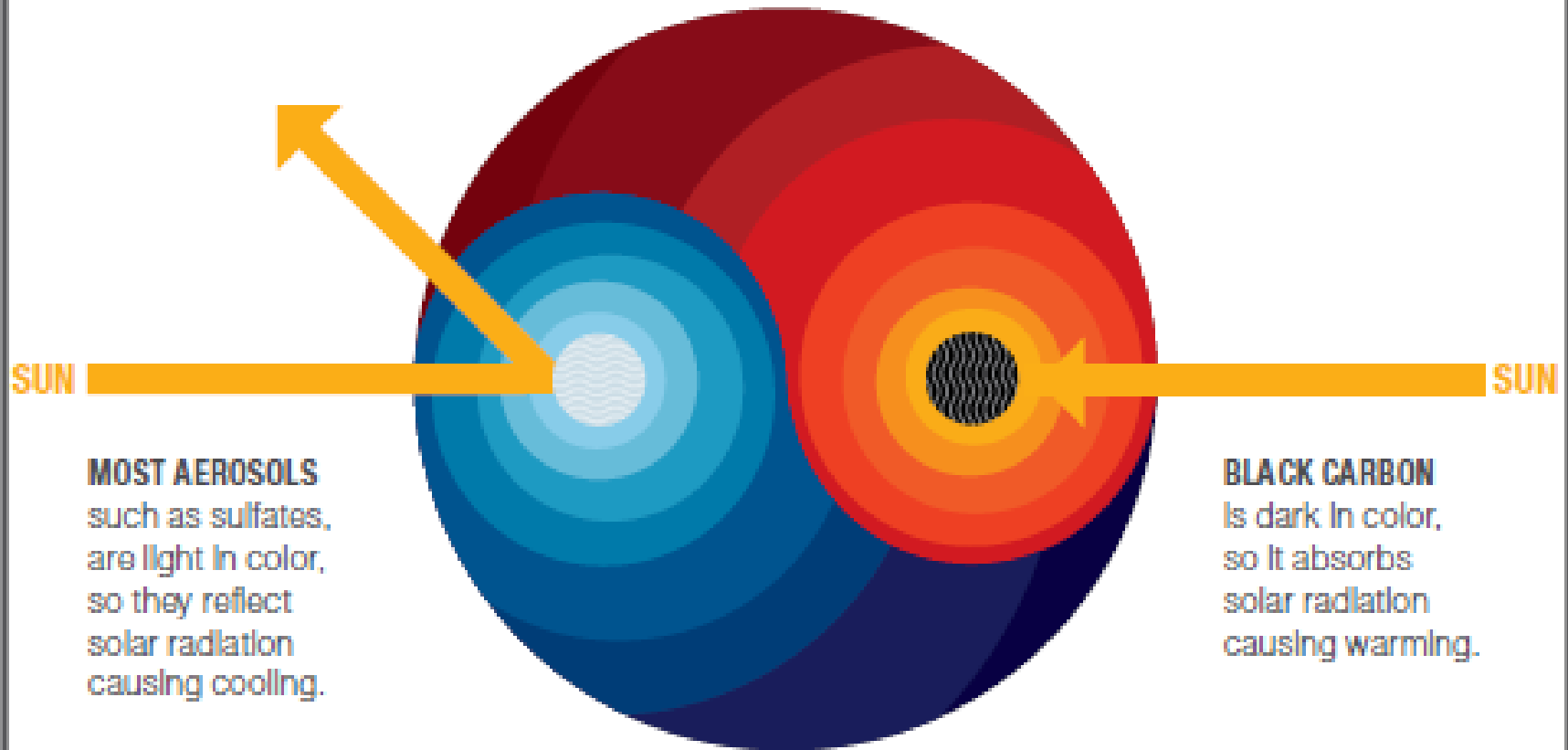
Black carbon is a particulate aerosol resulting from the incomplete combustion of fossil fuels, biomass and biofuels.

That is, it's one of the particles (soot) that result from the fact that these substances don't always burn completely.

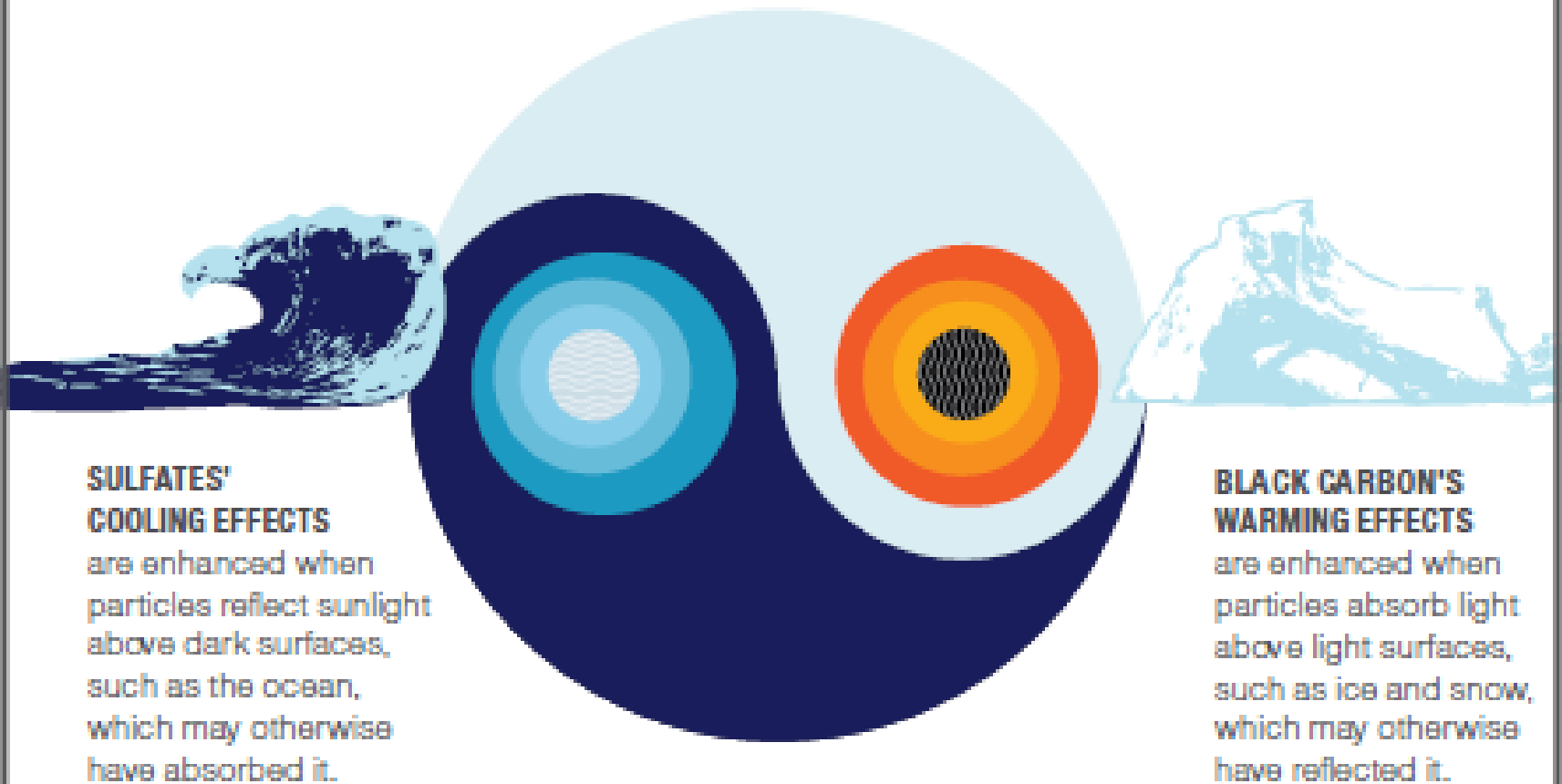
Direct Effect of Aerosols

- The direct effect refers to the process by which aerosols in the atmosphere scatter and/or absorb sunlight, cooling or warming the atmosphere accordingly.
- Aerosols such as BC, as well as some dust and organics, absorb sunlight and emit it as heat, warming the atmosphere.

AEROSOL CLIMATE EFFECTS



REGIONAL IMPACTS



BC Snow/Ice Albedo Effect

- “Soot has an additional forcing mechanism, referred to as BC-snow forcing, when it is deposited to snow and ice surfaces. Such deposition darkens the surface which enhances the absorption of solar radiation thereby warming the lower atmosphere and inducing snow and ice melting.” [Quinn, et. al. 2008]

Black Carbon Meltwater Feedbacks

Hansen and Nazarenko (2004):

“Soot deposition increases surface melt on ice masses, and the meltwater spurs multiple radiative and dynamical feedback processes that accelerate ice disintegration.”

More Feedbacks

- BC's melting effect can be especially harmful in areas such as the Arctic and Tibetan Plateau where ice masses are threatened by excessive melting.
- In addition, as large ice surfaces melt, their disappearance can reveal darker surfaces of land and sea beneath them. These darker surfaces absorb rather than reflect solar radiation, so once the reflective ice or snow surface above them melts, they start absorbing sunlight, causing additional warming.
- Thus, not only does BC's dark color absorb heat and cause melting, but such melting can compound warming through a pattern of positive feedbacks.

Black Carbon and Snow/Ice

Zender (2007):

Arctic climate is very sensitive to the surface warming that BC causes. Aerosol heating, cloud thickening, and dirty snow explain why black carbon warms the Arctic more than any agent except CO₂.

”Reducing Arctic BC concentrations sooner rather than later is the most efficient way to mitigate Arctic warming that we know of.”

(Based on Flanner, Zender, *et al.*, *J. Geophys. Res.*, 2007;)

Black Carbon and Snow/Ice

It's not just in the Arctic

Ming, *et al.* (2008, *Atmos. Res.*)

BC affects snow/albedo in glaciers in West China

US Pacific Northwest Lab (2009)

BC affects albedo/snowpack in the Western US

Flanner, Zender, *et al.* (2007)

BC warms 20 W/m² in the Tibetan Plateau in spring

Black Carbon Radiative Forcing

IPCC (2007; avg. of multiple studies)

Direct: +0.34 W/m²

Snow Albedo: +0.1 W/m²

Total: +0.44 W/m²

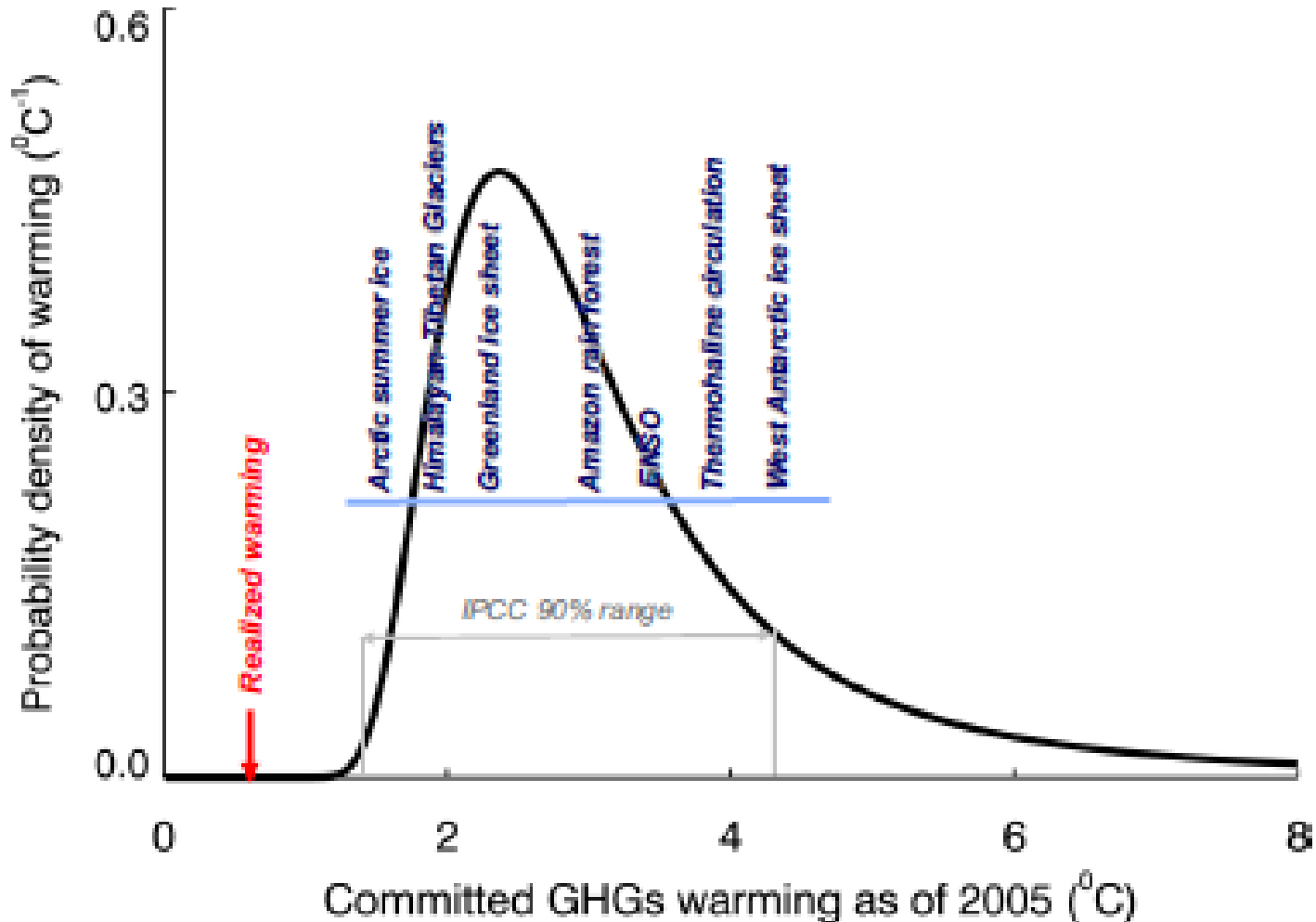
Ramanathan (2008)

Direct: +0.9 W/m²

Why Address BC?

- Why address BC rather than something else, just more CO₂ efforts, or other agents?
 - Because it can mitigate climate (cool) *fast*
 - And fewer people would die/suffer from health problems.
 - BC reductions complement both CO₂ reductions (climate) and sulfur reductions (health).

Why the Need for *Fast* Mitigation?



Aerosols can increase and decrease warming FAST

According to Philipona, et. al (2009), aerosol reductions (mostly sulfates) are responsible for 2/3 of the 1°C temperature increase over mainland Europe since the 1980s.

Aerosols can increase and decrease warming FAST

According to Ramanathan and Feng, existing sulfates are masking large amounts of warming that would otherwise be observable.

As planned sulfate reductions continue, they will result in 1°C warming over the next 50 years.

Aerosols can increase and decrease warming FAST

Reducing BC emissions is likely the only means of offsetting the rapid warming expected from sulfate reductions in the short term.

And BC reductions will have similar if not greater health benefits (per unit reduced) than sulfate reductions.

Global Atmospheric



Pollution Forum

**AIR POLLUTION AND CLIMATE CHANGE:
DEVELOPING A FRAMEWORK FOR INTEGRATED CO-BENEFITS
STRATEGIES**

Stockholm 17 - 19 September 2008

1. Current science emphasizes the urgent need to address air pollution and climate change in an integrated way.
6. Ground-level ozone and black carbon aerosols are both air pollutants and act as warming agents...cutting emissions could produce relatively quick climate benefits.
8. Decreasing black carbon emissions from the majority of diesel engines is effective and practical...

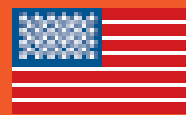
BC Policy Framework Options

- COP 15 decision on Programme of Work for Rapid Mitigation (stoves, diesel, boilers)
- Space in Copenhagen Agreement to add BC/Aerosols later
- Borrow existing regulatory structures
 - international (IMO, ICAO, LRTAP etc.)
 - regional (ASEAN haze treaty, etc.)
- Ensure eligibility in all climate funds (e.g. WB)
- Strengthen domestic regulations and focus on health and ag. co-benefits (e.g. PM 2.5)

SOURCES OF BLACK CARBON IN CHINA AND THE U.S.



IN CHINA, coal and biomass burning emit the majority of black carbon, with diesel vehicles contributing a smaller proportion.



IN THE U.S., diesel vehicles emit the majority of black carbon; coal and biomass burning contribute a smaller proportion.

BC Policy Actions

- Cooking stove replacements
- Diesel vehicles: engine efficiency, filter, retirement and retrofit requirements
- Improve efficiency of industrial boilers
- Regulate springtime ag. burning

For more information

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Or Read ***IGSD BC Climate Briefing Note***

Available at www.igsd.org