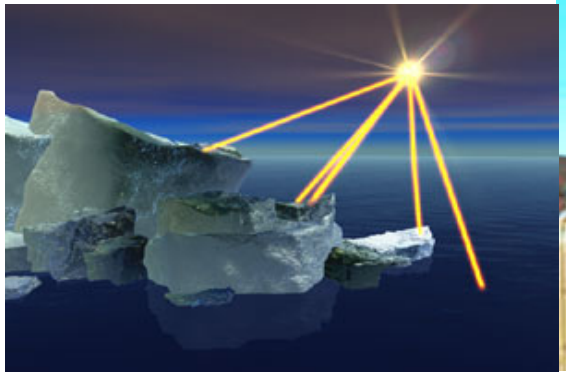
Reducing Black Carbon: An Opportunity for Fast Action to Slow Global Warming



Congressional briefing, Rayburn House Office Building.

Ellen Baum, Senior Scientist

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September 25, 2008

The Problem: Climate stabilization is not easy and the risks are large

- **Rapid decline in sea ice extent, potential of Greenland ice sheet reaching a point where loss cannot be reversed and melting will add to sea level rise.**
- **Despite understanding the CO_2 needs to go down, emissions and atmospheric concentrations are increasing.**
- **Last week in PNAS, Dr. Ramanathan concluded that, even with steep CO_2 reductions, the Earth is committed to 3°C by 2030, with nearly 50% of this warming coming from clean up of air pollution that has been masking some of the warming in the pipeline.**
- ***To slow climate change effectively, we need rapid reductions of short-lived climate forcings in parallel with deep reductions in CO_2.***

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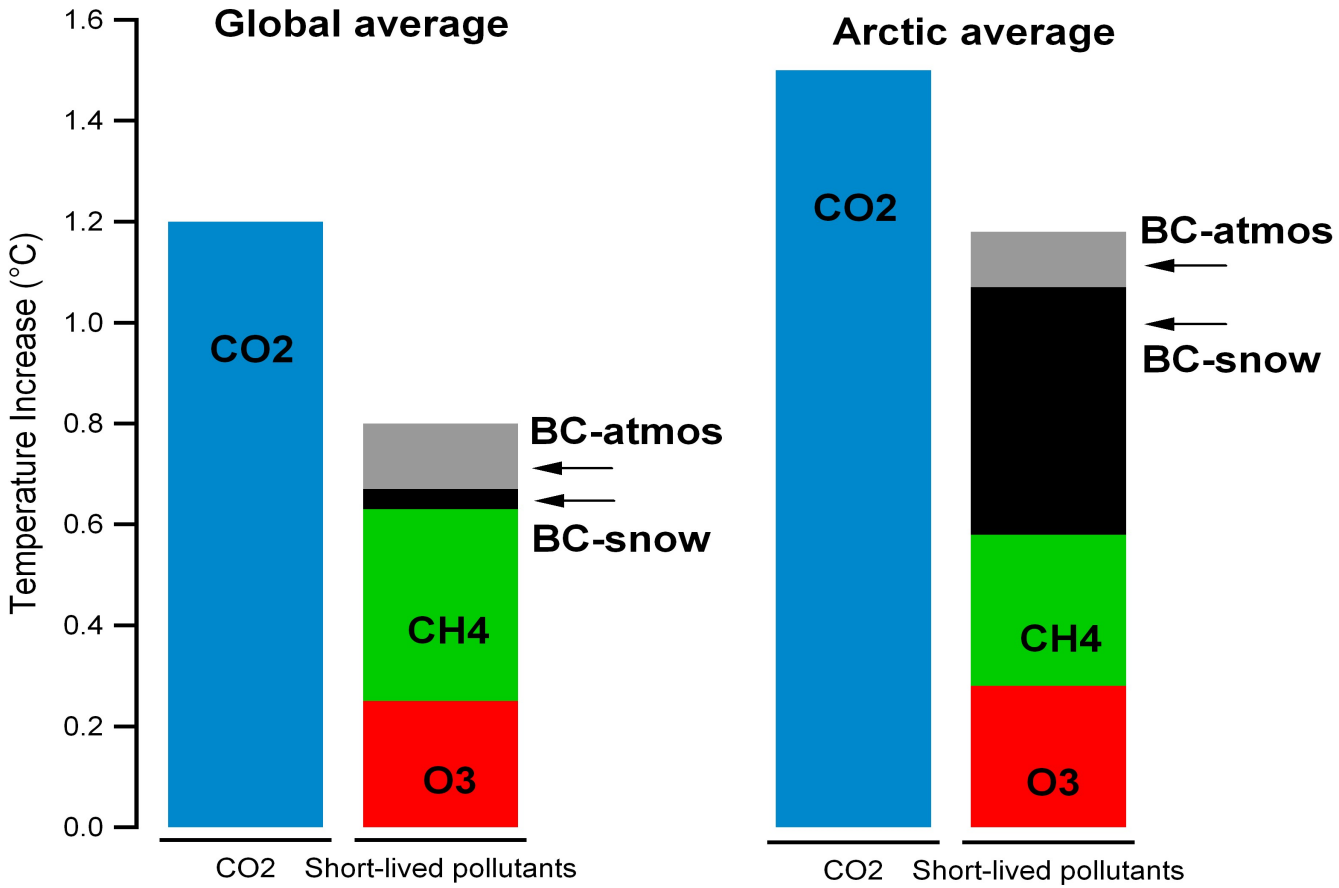
Short-lived forcers have a comparable impact to CO2



Quinn, Impact of Short-Lived Pollutants on Arctic Climate, presented at AMAP, Oslo, September 15 2008

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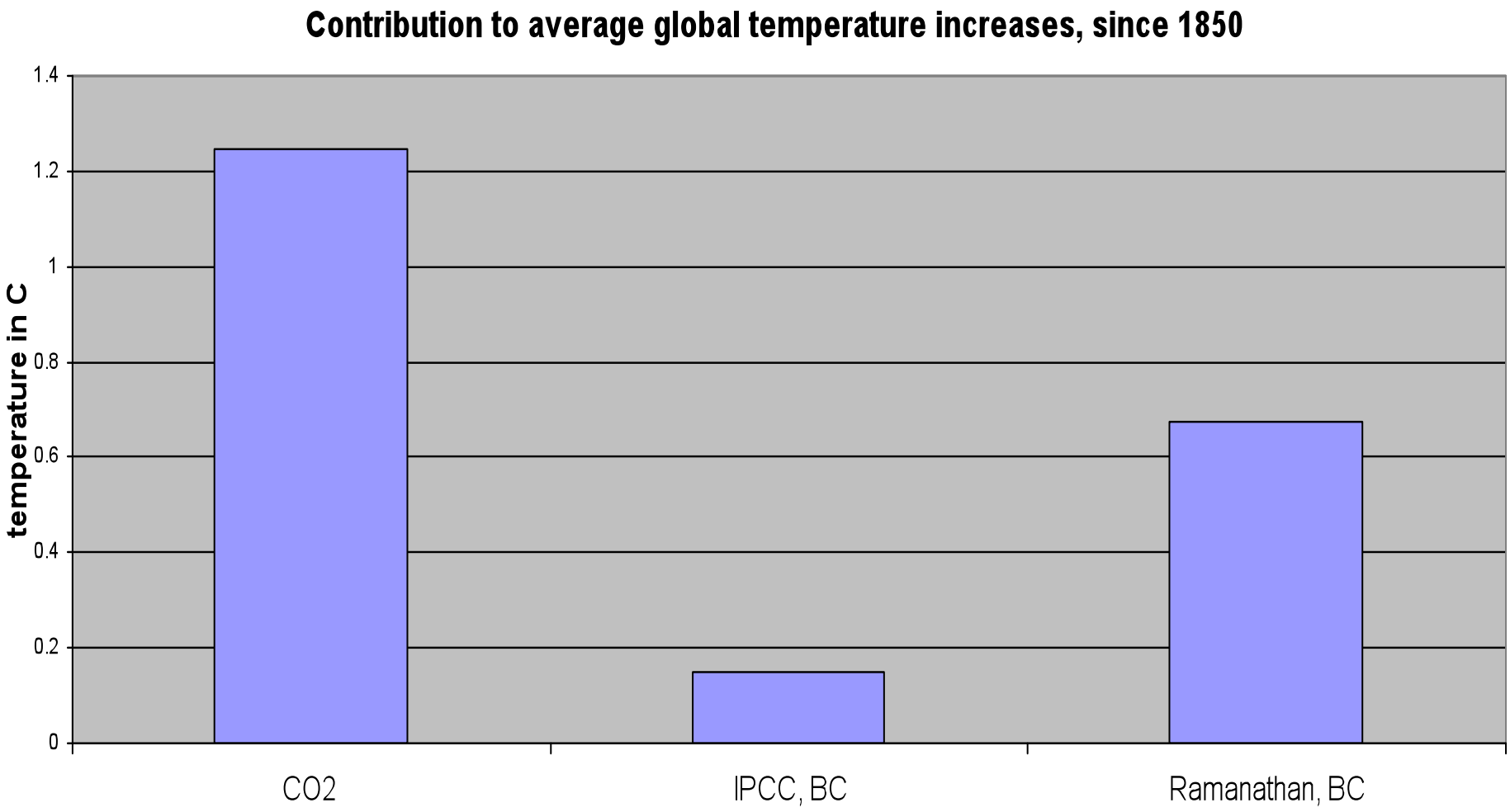
By some calculation, black carbon climate response may be even greater



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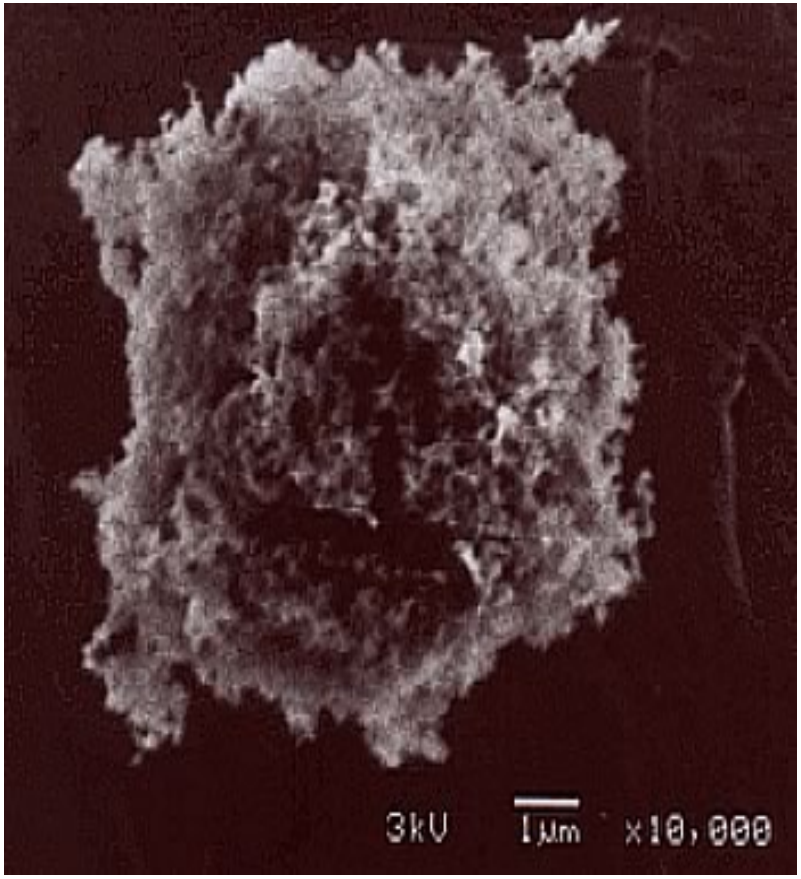
What is black carbon?



- Black carbon -- soot -- consists of dark particles left over from incomplete combustion of fossil fuels and biomass.
- Absorbs sunlight and heats up the atmosphere.
- Unlike CO_2, the warming effect of black carbon is short-lived, lasting days to weeks.
- Black carbon also harms human health.

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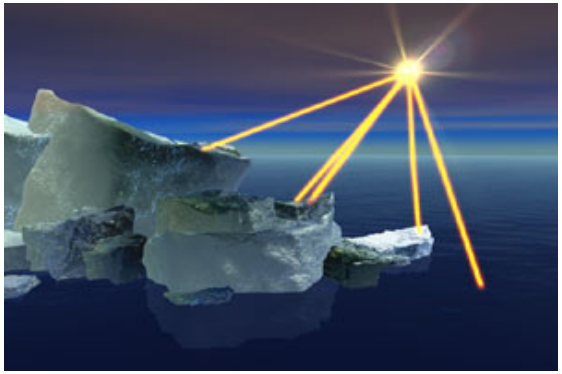
Black Carbon Warms both in the Atmosphere and by Darkening Arctic Ice, Accelerating Melting

Soot deposited on snow and ice absorbs more of the sun's energy and warmth than an icy, white surface that reflects sunlight. Such soot deposition can both warm the air above the ground surface and also contribute to snow and ice melting. These effects suggest that soot may play a particularly important role in arctic climate change, but is likely affecting land-based glaciers as well.

In the atmosphere, like an asphalt road, black carbon soot absorbs sunlight.

Ice and Snow Reflect Solar Radiation



Black Carbon Deposits Darken Surface and Reduce Reflectivity

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Sources of Black Carbon

Dirty Diesels

Smoking Cookstoves

Burning Fields

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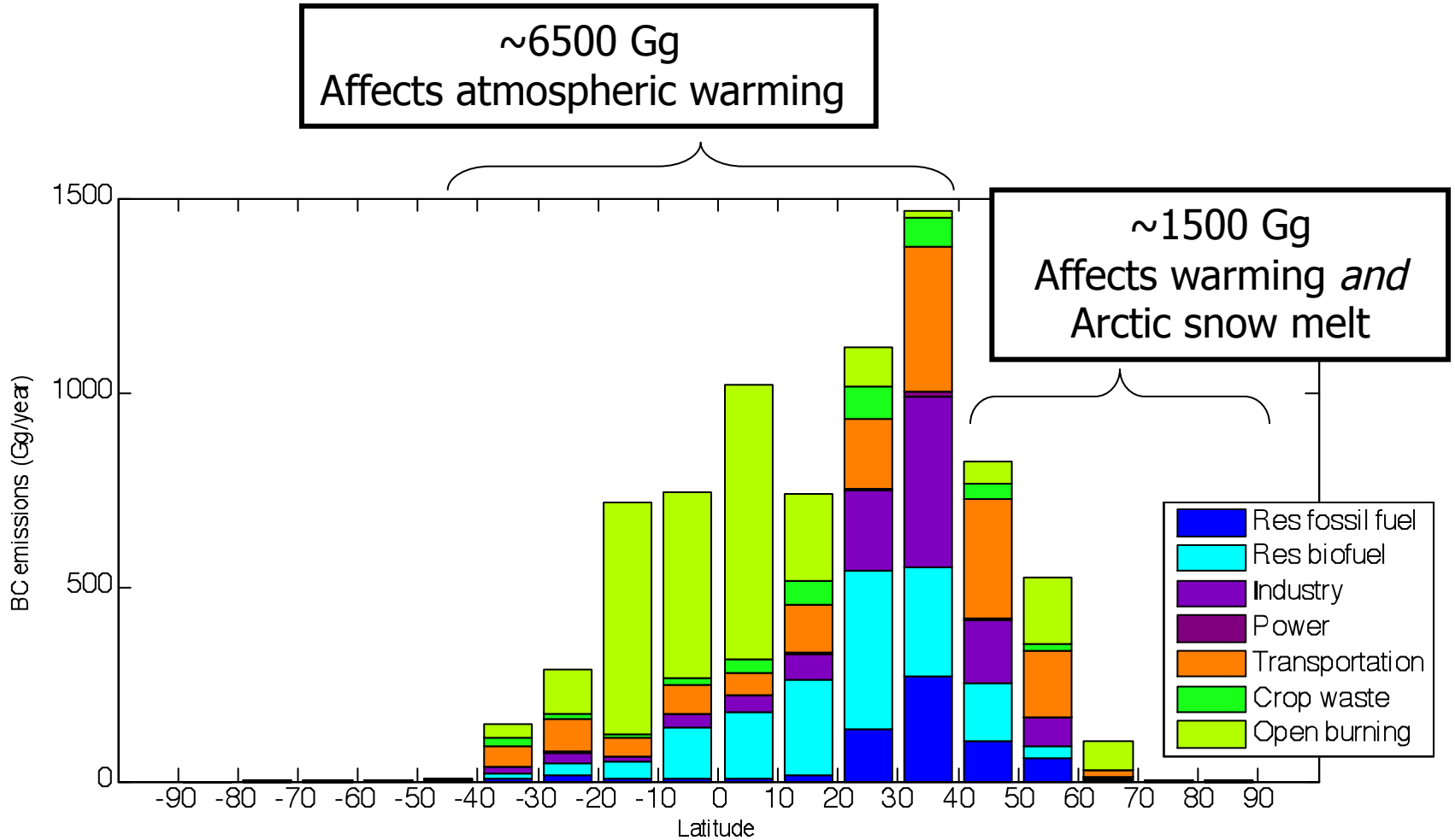
Sources and their likely atmospheric effect and snow effects



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Source: Bond et al., 2004 (updated to year 2000 data); GFEDv2 (van der Werf, 2006)

The challenge: there is no such thing a "just" black carbon emissions

- All sources that emit black carbon also emit organic carbon and other aerosols, which have a largely cooling impact.

- While gram for gram the warming from black carbon is more potent than the warming from other forcings, policymakers need to be aware of the balance of black carbon, organic carbon, sulfates and nitrates.

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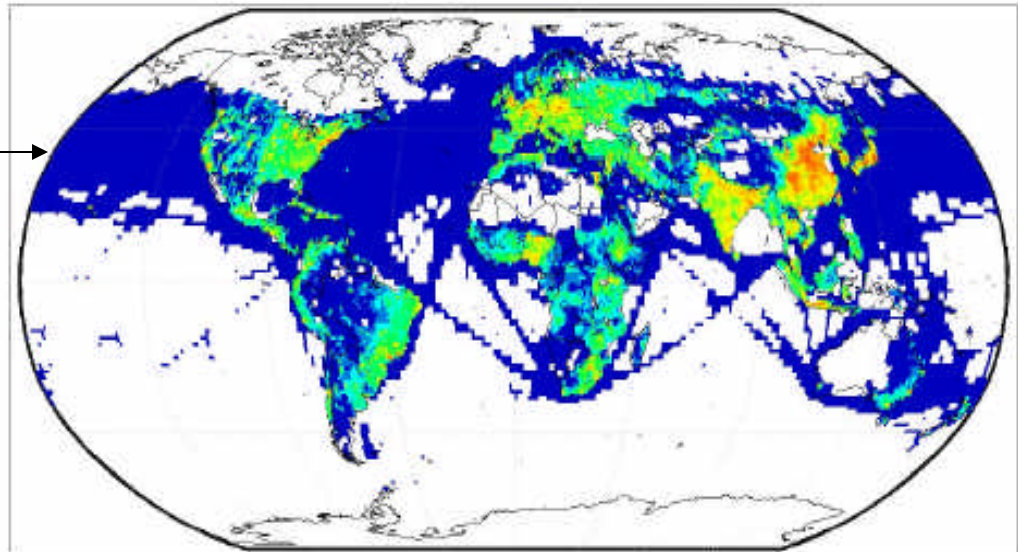
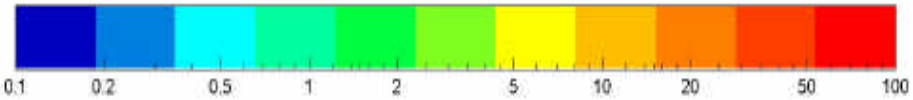
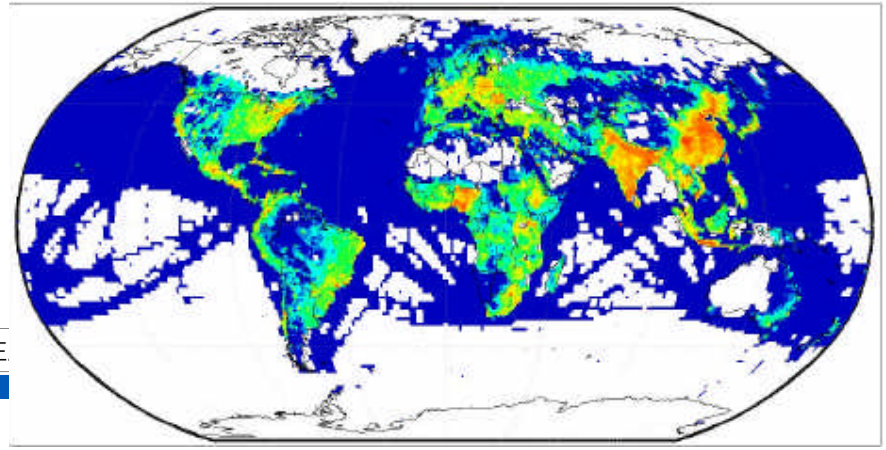
Emissions of black and organic carbon aerosol from fossil fuels and cookstoves

Black carbon





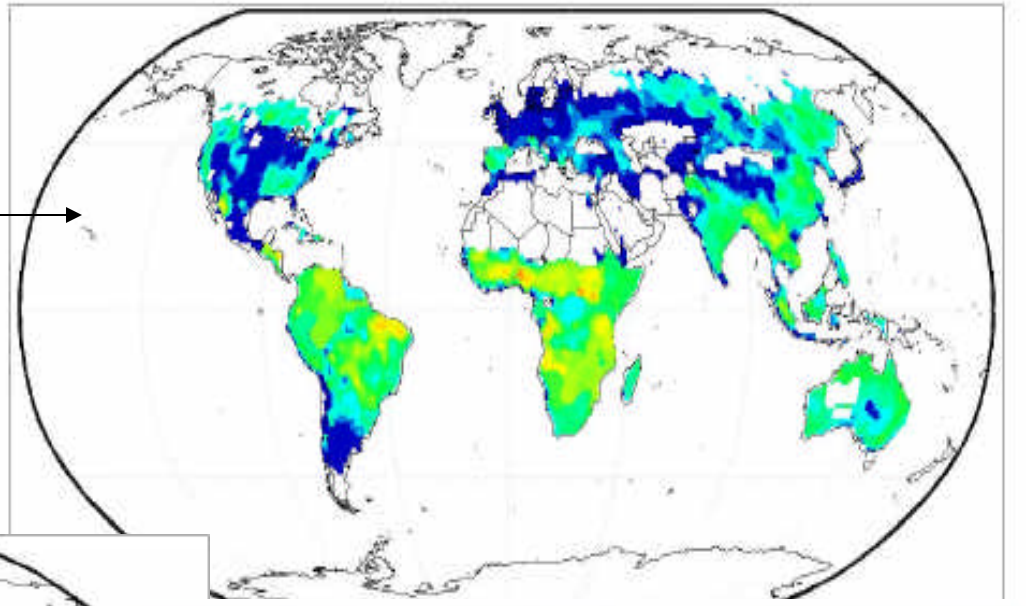


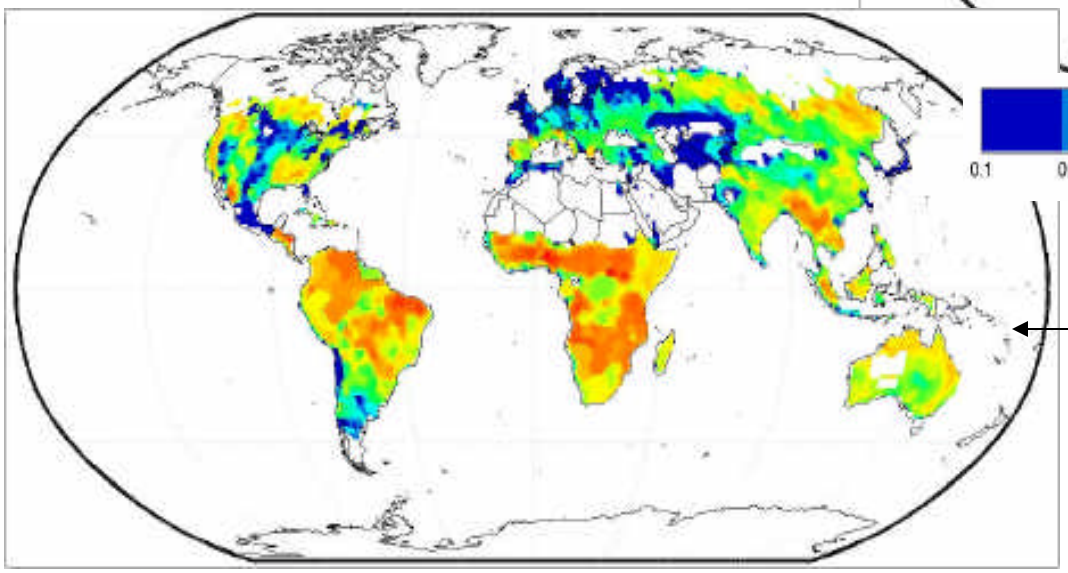
Organic carbon

Source: Bond et al., 2004

Emissions of black and organic carbon aerosol from open burning

Black carbon





Organic carbon

Source: Bond et al., 2004

We can develop mitigation strategies that, will, on balance result in climate benefit

		Known Arctic deposition	Atmospheric warming	Mitigation feasibility	
Diesel engines	24%	yes	STRONG	EXISTS	POSSIBLE
Domestic biofuel	18%	OPEN Q	STRONG-MOD	EXISTS	POSSIBLE
Domestic coal	6%	OPEN Q	OPEN Q	EXISTS	POSSIBLE
Industry	10%	yes	OPEN Q	EXISTS	POSSIBLE
Open biomass	42%	yes	OPEN Q	QUESTIONABLE	

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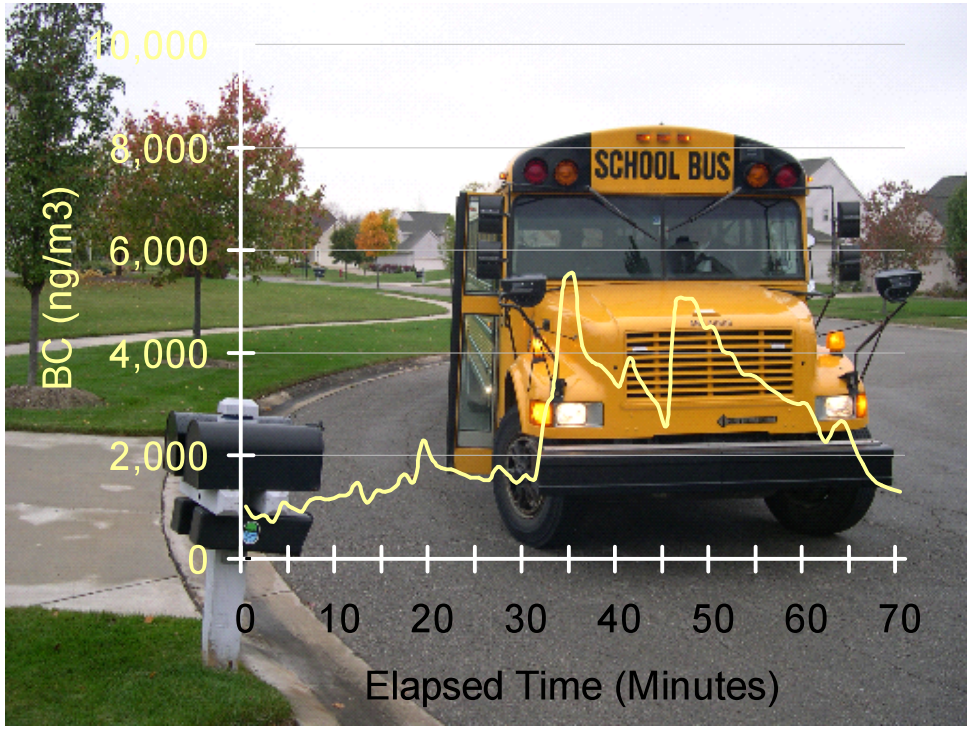
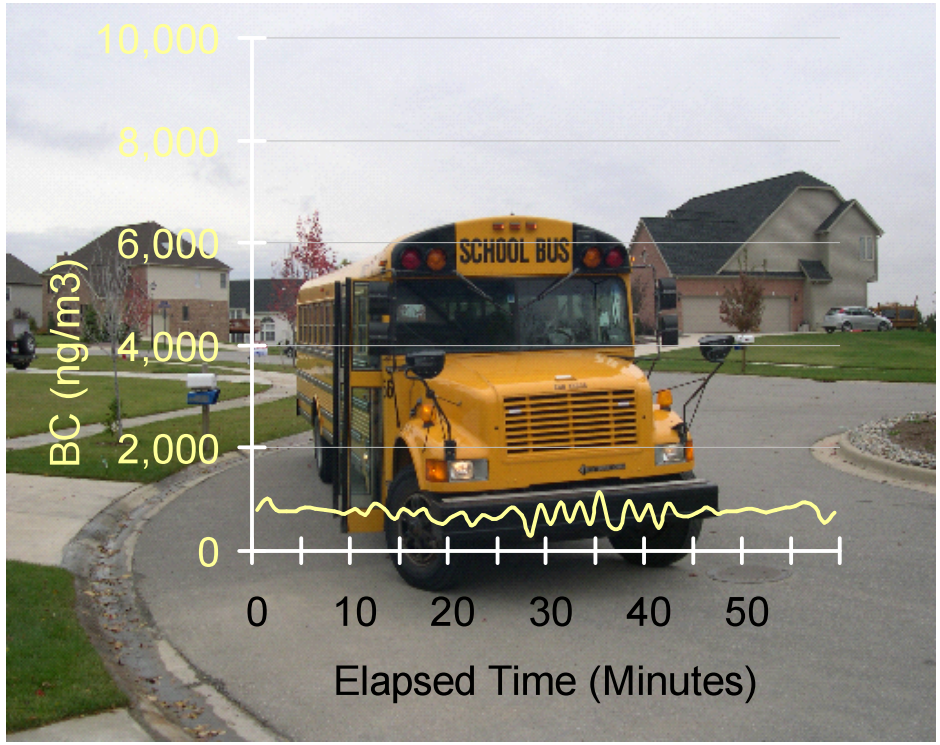
Source: Bond et al., 2004 (updated to year 2000 data); GFEDv2 (van der Werf, 2006)

Solutions: Diesel Particulate Filters Remove Black Carbon Today





BEFORE FILTER:
High Black Carbon Conventional Bus
On Ultra Low Sulfur Diesel fuel
(USDL)

(in-cabin air)

AFTER FILTER:
Low Black Carbon
Filter-Equipped Bus
On ULSD fuel

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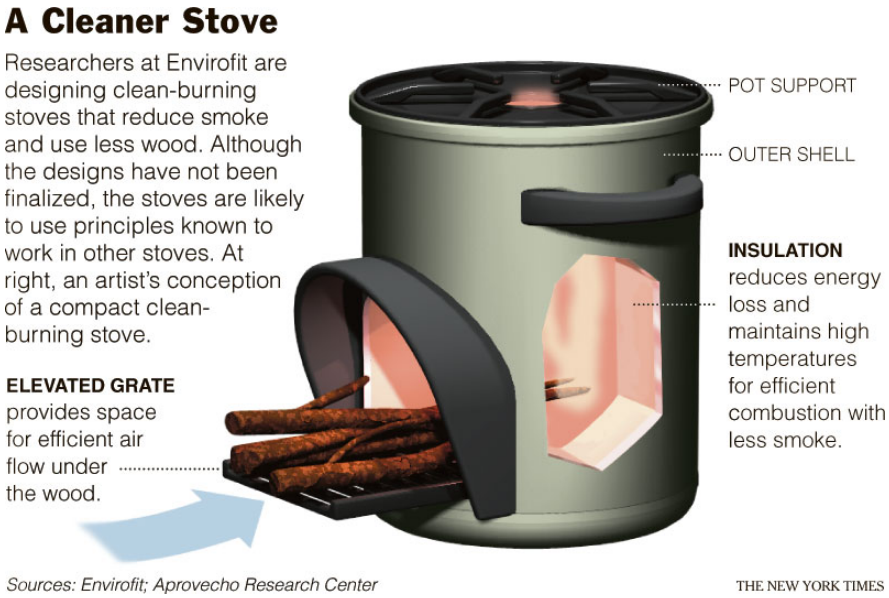
Other Possible Solutions



Clean Cookstoves

Mobile Pyrolysis Unit, Biochar production

Conclusion

- Curbing black carbon and other short-lived climate forcing agents *is likely the best, and perhaps the only viable strategy* for delivering atmospheric temperature reductions before 2050, offering the potential to avoid catastrophic climate responses.
- We need a strategy to deal with short-lived climate forcing agents like black carbon, ozone and methane for CO2 strategies to be effective.
- Congress can help by directing EPA and others in US government to better quantify the role of black carbon in global warming and target strategies to reduce emissions.

For more information

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