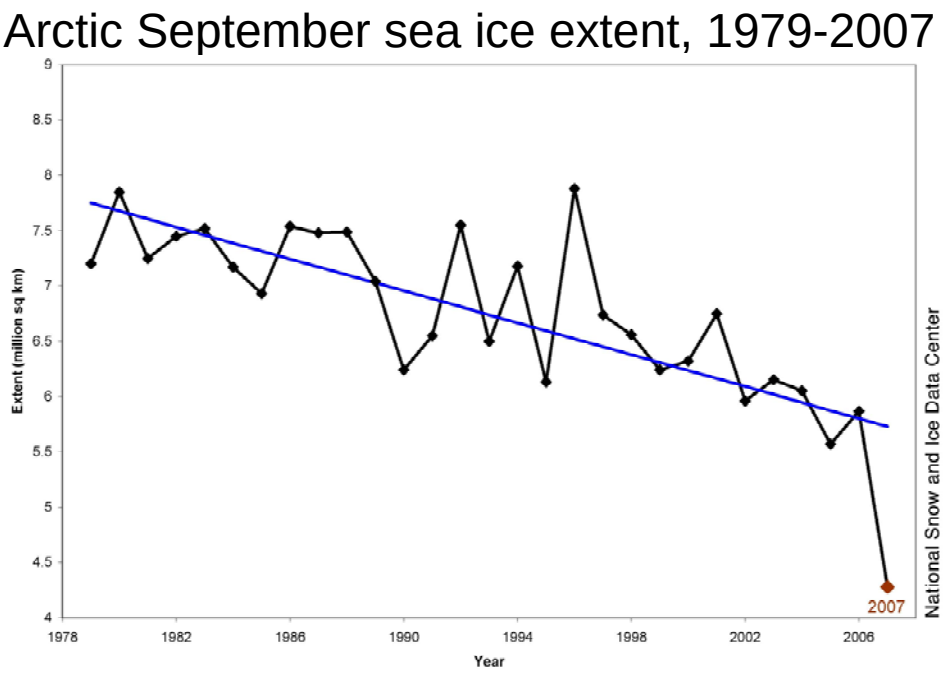
Possible "40 Degrees North" Black Carbon Initiative
Report from November 5-7 Oslo Meeting to
Arctic Council Meeting of Senior Arctic Officials
Narvik, November 28-29, 2007

Summary

Black carbon or "soot" consists of small dark particles arising from incomplete or inefficient burning, for example from diesel engines or wood burning stoves. These small particles can travel large distances from their source, including to the Arctic. Black carbon warms the Arctic in two ways. First, it contributes to overall global warming; and second, it deposits on snow and ice, making it darker and resulting in additional warming and melting. Unlike carbon dioxide, which remains in the atmosphere for decades, black carbon lasts only a few days or weeks. Despite its short lifetime, it may prove the second most important global warming species because it absorbs so much heat.

Although a large fraction of global black carbon comes from developing country sources, most of the black carbon deposited in the Arctic comes from countries above the approximate latitude of 40 degrees North. As a result, control of these sources (primarily diesel and biomass burning) in the Arctic Council member states and near-Arctic nations could have a large and very rapid impact in slowing the warming of the Arctic, including melting of ice in sensitive regions. In addition, reductions in methane and tropospheric ozone could also play a role in reducing Arctic warming and melting.



Background

With temperature increases twice the global average, no region in the world is warming faster than the Arctic. Ice cover measurements show rapid changes in summer melt. In recent years the melt season has begun earlier and ice return has come later. In 2007, in some regions of Greenland the melt season lasted three weeks longer than normal. In September 2007, large areas of Arctic sea ice were only one meter thick, about 50 percent thinner than they were in 2001. The extent of Arctic sea ice cover has decreased since 1979, and lost an area four times the land mass of Sweden during the 2007 melt season. The famed Northwest Passage was ice free for the first time since satellite records began in 1978.

What happens in the Arctic also has global impact. With its large expanse of heat-reflecting snow and ice, the Arctic serves as the "refrigerator" of the global climate system. Warming in the Arctic and near-Arctic could cause the release of large amounts of methane and carbon dioxide from permafrost, speeding up overall planetary warming. In terms of sea level rise, the 2007 IPCC projections of a 0.58 meter rise in sea level by the end of the century included no contribution from possible Greenland melt, because available models could not yet capture ice sheet dynamics. (Loss of sea ice, while not in itself leading to sea level rise, leads to earlier and longer ice-free-periods around Greenland, resulting in greater Greenland warming as the dark water abutting the ice sheet absorbs more heat.) Many mainstream scientists now believe that we will soon reach a "tipping point" for Greenland where extensive future melting becomes inevitable, with enormous implications for the unique Arctic environment, fauna and peoples.

Can we take measures to slow the rate of Arctic melting? Many of the ongoing changes in the Arctic climate remain a direct consequence of global warming due to increasing levels of CO2. Because atmospheric CO2 has a long lifetime (up to 25% remaining after 500 years), we will see continued warming and ice sheet melting in the future, reinforcing an urgent need for carbon dioxide reductions for the Arctic as well as the globe.

At the same time, important research points to a key, Arctic-specific possibility: that the rapid rates of current melting arise in large part from short-lived climate forcers such as black carbon (soot), methane and ground-level ozone. Addressing those agents through rapid international action may slow current rates of melting.

Black carbon and Other Short-term Arctic Climate Forcers:

Black carbon (BC) represents a special opportunity among the short-term forcers. These small particles (diameters less than one micrometer) arise primarily from incomplete combustion of fossil and biofuels – coal or wood stoves, diesel engines, or through forest and agricultural burning. With an atmospheric lifetime of a few days or weeks, models and direct sampling indicate that most of the black carbon reaching the Arctic comes from Arctic Council member states and Eurasia, at sources located at about 40 degrees North latitude and above.

Other, short-term climate forcers include methane and tropospheric ozone, and efforts to reduce these forcers similarly would help slow Arctic warming.

Arctic Climate Impacts

Black carbon (BC) emitted in the northern latitudes warms and melts in the Arctic through multiple mechanisms.

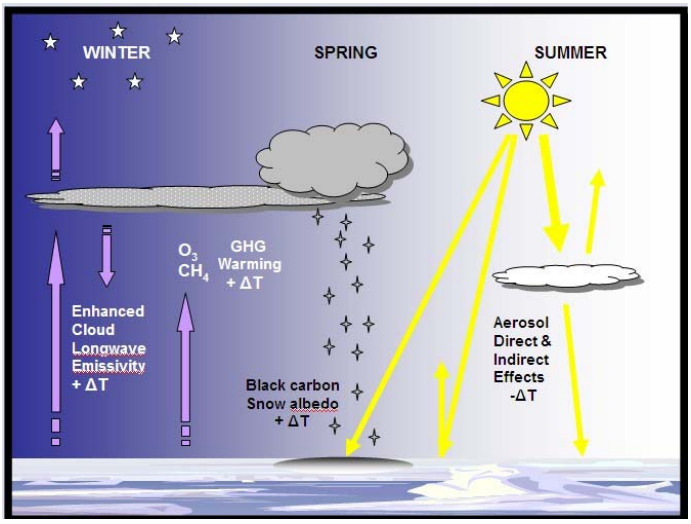
1. First, black carbon works as a global climate forcer. This happens because the dark, airborne particles absorb heat and warm circulating air. This global warming has a disproportionate impact in the Arctic. Most of the sources of the portion of black carbon that has this global impact arise from developing country BC emitters such as cook stoves.

2. Black carbon that reaches the Arctic ***-- and this comes primarily from Northern latitudes --*** can deposit on snow and ice. Once there, it absorbs heat, warming the surrounding ice and snow, and causes much higher rates of both local warming and melting.

3. Black carbon appears to change the crystal size of the snow around it, making the crystals larger and more apt to absorb solar radiation.

4. Where this additional melting leads to loss of sea ice or snow cover, warming accelerates even more, as the much darker surfaces of exposed land or open water absorb many times more heat, leading to an expanding feedback loop of additional melting and warming.

5. Finally, timing of black carbon deposition can affect melting. Deposition in winter and spring can result in an earlier onset of spring melt. The practice of agricultural burning in Eastern Europe and Russia, whereby farmers burn off stubble as soon as snow recedes in preparation for spring planting, is especially ill-timed in this respect.



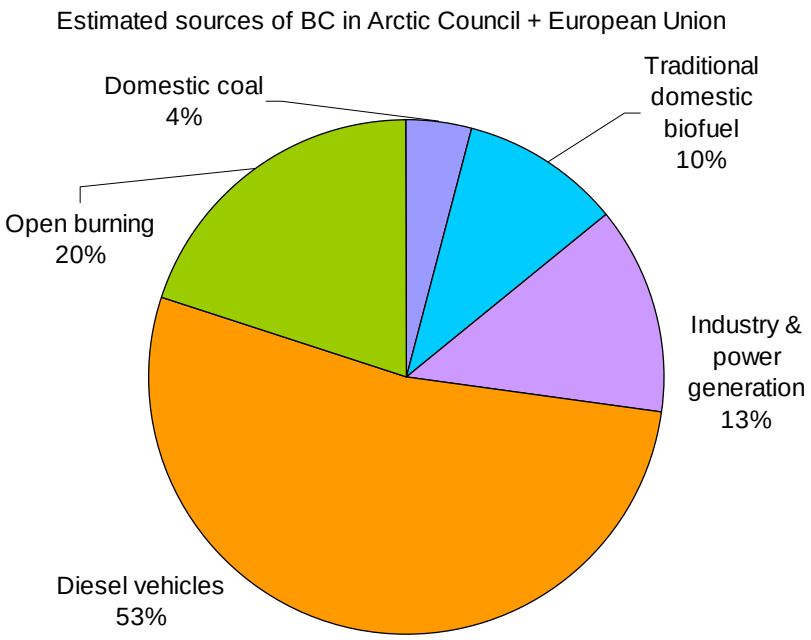
By all these mechanisms, black carbon emitted in the northern latitudes – though only 10-20% of global black carbon – has a magnified impact on the Arctic climate, first by contributing to the global impact, then magnified manifold by the various feedbacks of snow deposition: changing the snow and ice albedo; changing the form and properties of surrounding snow crystals; and exposing more heat-absorbing surfaces, especially when timed to affect spring melt. This also means, however, that reducing black carbon emissions at northern latitudes – especially at certain times of year – may have a correspondingly large impact by slowing that melting. Even shortening the melt season by a few days would make a difference in terms of less land and ocean surface exposed, and less warming, for the rest of the melting season.

Specific Sources

The greatest portion of the black carbon reaching the Arctic, and having this magnified impact on the Arctic climate, comes from the northernmost regions of North America and Eurasia above an approximate line of 40 degrees North, comprising the Arctic Council member states and some near-Arctic nations. Two main activities comprise these sources:

Particulate matter from diesel engines: The U.S. and EU have enacted strict regulations for particle emissions from new diesel engines. However, older engines and those without "particle traps" can emit large amounts of black carbon. A large portion of the existing automobile supply in Europe and Russia remains these older, dirtier diesel engines. Some diesel "super-emitters" – poorly-tuned engines-- can emit several times more particles than a single "old" diesel automobile. Off-road equipment, such as construction and farm equipment and diesel generators, generally has less stringent emissions regulations and can last for decades before replacement.

Solid fuel burning: Emissions from coal and wood stoves and boilers, as well as forest and agricultural burning, also contribute a large portion of black carbon from northern latitudes. In addition to the poorly-timed agricultural burning noted above, wildfires in Siberia, western Canada and the U.S., especially during the melt season, may be a damaging source of black carbon. Use of coal and wood stoves and boilers as a source of heating fuel in Northern and Eastern Europe can also emit significant amounts of black carbon.



Control Measures in the "40 degrees North" Nations

Long-term preservation of the Arctic environment will require deep reductions of CO2 as well as of short-term climate forcers globally. However, the magnified impact of black carbon from northern latitudes means that Arctic Council member states and other near-Arctic governments could take measures now that will slow the process of melting and warming in the Arctic relatively rapidly. Such measures, which also would have local health and air quality benefits, could include:

- An immediate ban on the practice of springtime agricultural burning throughout the region (such burning was banned decades ago in western Europe) – even encouraged for spring 2008;
- Requirements for retrofitting of all diesel engines with "particle traps", with a special emphasis on long-lived "super-emitters" in the transport, construction and agricultural industries as well as generators;
- Retrofitting or replacement of wood and coal stoves with other energy sources or low-emitting alternatives.

It is possible that reduced warming and a few days' additional ice cover, especially in springtime, could mean the difference between an Arctic rapidly approaching a "tipping point", and an Arctic with enough time for global measures to have sufficient impact to preserve its irreplaceable role in the global climate system. A targeted "40 degrees North" black carbon effort, together with global reductions in methane and tropospheric ozone precursors, could well buy us this time; and make the difference that counts, for the Arctic as well as the globe.