Considerations for Black Carbon within the Arctic Council Process

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The United States Delegation of the Arctic Council

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General background

Black carbon (BC) emissions are known to lead to negative health effects as a component of fine particulate matter (PM). BC emissions also lead to climate warming by absorbing incoming and reflected sunlight in the atmosphere and by darkening clouds, snow and ice. In contrast to the long-lived, well-mixed greenhouse gases, BC emissions remain in the atmosphere for a period of only days to weeks, meaning that their atmospheric concentrations are more variable which in turn means the location of mitigation measures can be more important for either regional health reasons or for protecting the Arctic. Organic carbon (OC), which under most conditions has a cooling effect, is always co-emitted with BC in ratios that vary with source type; both are products of incomplete combustion. Nitrogen dioxide and sulfur dioxide, also products of combustion, are often co-emitted with BC and OC and form particles that tend to have a cooling effect. Thus, the net cooling effectiveness of BC emission reductions will depend on the source type as well as the source location. The total climate impact of BC currently in the atmosphere has been estimated to be anywhere from 10% to more than 60% as large as the climate impact from carbon dioxide (CO_2). One half to two thirds of the BC impact results from fossil fuels, with the remainder from biomass burning.

Connections and Interest for the Arctic Climate

One of the reasons for increased attention to BC reductions is that there is growing confidence that BC is a significant contributor to the high rates of observed Arctic warming and associated ice melt. Because of the snow-albedo effect from deposition of BC, and because BC in the atmosphere causes more warming when over reflective surfaces, BC has larger proportional impacts in the Arctic than elsewhere. It has been suggested that BC emission sources that are north of 40^o latitude are generally thought to be the most relevant for the Arctic climate, though some modeling studies suggest that South East Asian sources may be significant contributors as well (up to 30% of current Arctic BC). Because BC has a short atmospheric lifetime, reducing these emissions should have more immediate and near term climate benefits for the Arctic than reducing the long-lived GHGs, which is necessary in the longer term. Because OC cooling mechanisms are not as effective over snow in the Arctic, the net effects of reducing particulate carbonaceous particle emissions (BC+OC) may also be larger in the Arctic than in other locations.

Emissions and Policies

While BC has not been included with the greenhouse gases (e.g., CO_2, methane) in formal climate policy considerations to date, such as the UNFCCC process, it has been addressed in many OECD nations through efforts to regulate PM emissions for air quality and health reasons. Diesel vehicles have been the largest BC source in the United States. However, these emissions are expected to decline significantly over the next several decades through PM diesel exhaust regulations for new vehicles. The EPA is evaluating the effects of its air quality policies on BC and the feasibility and cost of additional mitigation options.

Within the United States, Canada, and the European Union, the key BC emission sources are from transportation. Power generation, though a significant source of CO_2, is a small source of BC. In Eastern Europe and Asia, household fuel combustion and springtime biomass burning have significant potential for BC reductions. Industrial sources (especially in Russia) may be a larger component of emissions as well. While BC emissions from industrialized nations are expected to continue to decline due to air pollution regulations, BC emissions in developing nations are likely to continue to rise. If, as expected, Arctic shipping increases, there is also a potential for increased marine vessel BC emissions in the high northern latitudes such that emission limits on ships in that region could be especially beneficial.

The radiative forcing from organic carbon is generally similar in its spatial pattern to black carbon, but of opposite sign and substantially reduced magnitude (25 to 40 percent of the black carbon radiative forcing). In terms of the BC to OC ratio, in general the BC content of emissions is highest for fossil fuels, intermediate for biofuels, and lowest for open burning. For this reason diesel emission reductions will give the largest climate benefits per ton of BC reduced. Reductions of BC emissions from domestic biofuel use are a likely source of net climate benefits as well. There are likely to be benefits in the Arctic by limiting northern springtime agricultural burning through the use of alternative techniques including biochar production.

<u>Outcome of Arctic Monitoring and Assessment Program (AMAP) Workshop, Oslo</u>

The AMAP Workshop on Non-CO2 Climate Forcings (Oslo, 15-16 September 2008) recommended consideration of forming a workgroup to evaluate feasible mitigation options and pan-Arctic implementation strategies. This workgroup would be most useful if it were to provide further scientific, technical and policy option guidance in advance of the Arctic Ministerial in April 2009. Without some clear recommendations, it may be 2 more years before the Arctic Council has another opportunity to take action. The AMAP workshop also encouraged outreach to other international policy forums such as LRTAP Convention (the Executive Body meeting in December, and the Gothenburg Protocol revision being key targets), the UNFCCC (perhaps including a side event at COP-14 or 15), UNEP, and the International Maritime Organization.

<u>Potential Next Steps Leading up to the Arctic Ministerial in April</u>

For the Arctic Council SAO meeting on November 19-20, 2008, the SAOs may recommend that the Ministers:

- Continue to assess the state of the science in terms of BC and tropospheric ozone impacts in the Arctic under AMAP;
- Compile a report on regulatory and non-regulatory activities among Arctic nations and their projected impact on future BC emissions;
- Identify technologies, programs and management practices that have the potential to achieve additional BC reductions, along with an assessment of associated costs and health benefits;
- Identify actions to be taken on behalf of the Council and by the Arctic nations in the period 2009-2010 (Danish chairmanship), including, as appropriate, a role for the Arctic Contaminants Action Program (ACAP) working group.

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Scientific Uncertainty

There is considerable uncertainty remaining in terms of emissions inventories, atmospheric loading and transport, and radiative forcing and other climate effects of BC and co-emitted pollutants. There is also much uncertainty regarding BC effects on large and small scale precipitation. Research does and should continue on all these fronts, but for the most part the major uncertainties are not likely to be resolved on the timescale of the next few years (i.e., the timescale relevant for the Arctic Council process). One possible exception is near term improvement in inventories from sources such as home heating with oil and some industrial sources which might be good targets for easy reductions.

However, there is a consensus that despite the uncertainties there are actions that can be taken that will clearly benefit the Arctic climate and public health, and it is import to highlight what these actions are and what mechanisms are available to implement these actions.