Arctic Council Task Force on Short-Lived Climate Forcers:

Progress Report and Recommendations for Ministers

The Arctic Council Ministerial Tromsø Declaration from April 2009 created the Task Force, charging it:

> *to identify existing and new measures to reduce emissions of these [short-lived climate] forcers and recommend further immediate actions that can be taken and to report on progress at the next Ministerial meeting*

In November 2009, the Senior Arctic Officials (SAOs) further refined this charge through the approval of Operating Guidelines that agreed the Task Force could initially focus on black carbon; include national representatives, permanent participants and a variety of experts; co-operate closely with the Arctic Monitoring and Assessment Program (AMAP) Short-Lived Climate Forcers (SLCFs) Expert Group; and report periodically back to the SAOs on progress.

The focus on black carbon does not represent a judgment by the Task Force that black carbon is more important than methane or other climate forcers in terms of Arctic impacts. Rather, this focus acknowledges the unique role black carbon may be playing in the Arctic, its need for study as a frontier area of science, and the need for new technical analyses and emission inventories to inform the Task Force's recommendations regarding black carbon emission reduction measures.

The Task Force has developed an underlying technical report focusing on emission trends and projections, existing policies and programs, and potential mitigation options for black carbon. This technical information, plus the scientific findings of AMAP[1] and other completed assessments, is informing the Task Force's key findings and recommendations contained herein. For findings and conclusions of the AMAP Expert Group, the Task Force refers to their report.

Key Findings

Carbon dioxide emissions are the dominant factor contributing to observed and projected rates of Arctic climate change. However, addressing short-lived climate forcers such as black carbon, methane and ozone offers unique opportunities to slow Arctic warming in the near term.

Black carbon emitted both within and outside of the Arctic region contributes to Arctic warming. Per unit of emissions, sources within Arctic Council nations generally have a greater impact.

Reducing emissions from any black carbon source will likely benefit the Arctic climate system; but analysis by AMAP and others indicates that mitigating in- or near-Arctic sources

[1] We note for SAOs that the most recent AMAP results are not yet finalized, and that a UNEP/WMO assessment is scheduled to be published February 2011, entitled *Limiting Near-Term Climate Change and Improving Air Quality: an Integrated Assessment of Black Carbon and Tropospheric Ozone*.

will have a greater Arctic climate impact than the size of these sources alone would indicate. Nevertheless, because emission sources outside of Arctic Council nations are large, these are also important in terms of Arctic climate change.

There are strong regional differences between the climate effects of black carbon sources in the Arctic versus most other parts of the world.

Scientific uncertainty remains about the magnitude and nature of the climate impact of black carbon emissions globally. In addition, sources of black carbon emit a complex mixture of substances, some of which may cool the climate, such as organic carbon or sulfates. However, in the Arctic, the potential for such offsetting effects from non-black carbon aerosols is weaker. Over highly reflective surfaces such as ice and snow in the Arctic, the same substances that might cool the climate in other regions may cause warming since they are still darker than ice and snow. This warming impact is magnified when black carbon physically deposits on snow or ice. Emissions closer to the Arctic have a greater chance of depositing, and thus appear to have greater impact per unit of emission. Despite these facts that lead to greater confidence in the net warming effect of black carbon sources in the Arctic, the exact magnitude of this warming remains an area of scientific uncertainty, and hence subject to continued active research.

Unlike the case for methane and other well-mixed greenhouse gases, the most effective black carbon control strategies for Arctic climate benefits will vary by location and season.

Additional measurements, research and analysis will be needed to better identify which specific black carbon mitigation measures—both inside and outside of the Arctic Council nations—will lead to the largest Arctic climate benefits.

Black carbon concentrations in the atmosphere are variable from one region to another, and over different seasons, because black carbon remains in the atmosphere for only days to weeks. This means Arctic impacts will vary with the black carbon source and location, and with the timing or season of emission (which influences how much sunlight is available). Greater understanding of these factors as they apply to specific emission sources in specific locations will help ensure selection of effective controls. Importantly, these scientific uncertainties do not call into question the fact that the recommended measures would reduce the emissions of black carbon.

Controls on black carbon sources that reduce human exposure to particulate pollution improve health, and in that regard many measures can be considered no-regrets.

Measures aimed at decreasing black carbon emissions have positive health effects for any community exposed to the particulate matter emissions containing black carbon. The Task Force therefore wishes to stress that many early mitigation measures can be considered “no regrets” because of health co-benefits including reductions in premature deaths and avoided health care costs, despite remaining uncertainty in quantifying the Arctic climate benefits. A key consideration for the Arctic Council in future measures should be the impact on and benefits to all Arctic communities, including indigenous peoples and others affected by exposure to black carbon particulate pollution.

The largest sources of black carbon emissions in Arctic Council countries have been identified.

The largest Arctic regional emission sources arise from **land-based transportation** (primarily on-road and off-road diesel vehicles), **open biomass burning** (agricultural and forest burning); and **residential heating**. **Marine shipping** constitutes a potentially significant source, especially in the Arctic due to its projected increase over time and its proximity to snow and ice. **Gas flaring** is a source that requires special attention to improve the understanding of its size and importance.

To maximize climate benefits, particulate matter (PM) control programs should aim to achieve maximum black carbon reductions.

No Arctic governments currently control black carbon per se. While PM controls do help to decrease black carbon emissions, the effect of these controls on black carbon emissions are not always proportionate. This is because the amount of black carbon in directly emitted PM varies by source, and also because PM mitigation programs that focus on sulphur and nitrogen oxides may not lead to reductions in black carbon. Therefore, black carbon-specific efforts for regional climate purposes can be worthwhile as a complement to existing PM controls for health and environmental purposes.

Total Arctic Council black carbon emissions are projected to decrease if existing and planned land-based transport regulations are effectively implemented, though this is not uniform across countries or sectors.

Overall black carbon emissions from Arctic Council nations have been projected to decrease in the coming two decades as a result of existing and planned regulation of PM emissions from land-based transportation sources. These controls are motivated by health and other, non-climate environmental impacts. The rate and magnitude of this decrease will, however, depend on how quickly and effectively this legislation is implemented, as well as how rapidly older vehicles not covered by the new legislation are retrofitted or retired from use.

Emissions from sources other than land-based transport will likely remain the same or increase without new measures.

Few existing or planned regulations in Arctic Council nations will lead to decreases in black carbon emissions from residential heating, agricultural and forest burning, and marine shipping. Emissions from residential heating may grow, since many Arctic nations have turned to wood fuel in recent years. As marine shipping increases in general and in the Arctic, black carbon emissions may increase in close proximity to Arctic snow and ice. Without new policies or measures, there is also no compelling reason to expect a downward trend in emissions from agricultural and forest burning. As a result, there remains much that Arctic Council nations can do to further decrease their own black carbon emissions.

Co-operation in other international forums is needed.

Although sources within the Arctic region are important, work by the AMAP Expert Group and others indicates that a significant share of black carbon impacting the Arctic appears to come from outside Arctic Council nations. As a result, cooperation with related efforts of other forums, such as the International Maritime Organization (IMO), the Convention on

Long-Range Transboundary Air Pollution (CLRTAP), the United Nations Environment Programme (UNEP) and the UN Framework Convention on Climate Change (UNFCCC), as well as non-Arctic Council countries, is key to addressing the near-term impact of SLCFs in the Arctic, especially as a co-benefit of air pollution control efforts. The Arctic Council could help inform these processes about the role of SLCFs and Arctic impacts as part of an overall climate strategy.

Recommendations for the Arctic Council and Its Member Nations

Based on the above findings, the Task Force recommends that Arctic Council nations individually and collectively work to implement some early actions to reduce black carbon.

The Task Force believes there can be a strong role for the Arctic Council and Arctic nations to lead in highlighting the importance of Arctic climate protection, not only for the Arctic region and its people but for the global climate system, and highlighting the role that black carbon may play in Arctic climate protection strategies. By taking a leading role on black carbon through voluntary or other national and international actions, the Arctic nations could also contribute to future initiation of SLCF efforts in other regions where black carbon sources are found to have specific regional climate impacts.

The Task Force recommends that Arctic Council nations continue their efforts to estimate and develop black carbon emission inventories, and to voluntarily and periodically share these inventories.

There is still considerable uncertainty regarding the quantification of black carbon emissions, particularly from sources such as agricultural and forest burning and gas flaring. The emissions inventory work undertaken to support the Task Force has been of significant value to identify important emission trends and additional mitigation opportunities. This work should continue and be strengthened, in close coordination with scientific work on impacts as noted elsewhere in this document. The Task Force also notes that the Executive Body under CLRTAP—to which all eight Arctic Council nations are party—recently decided to include consideration of black carbon in the revision of the Gothenburg Protocol, and also called for work on guidelines for black carbon inventories (as well as ambient monitoring and source measurement), with a view to begin voluntary national reporting in the near future.

The Task Force recommends that Arctic Council nations consider specific mitigation options for the transport, residential, agricultural and forest burning, and shipping sectors; and periodically share information on progress in reducing their black carbon emissions.

Not all of the measures outlined below will prove equally appropriate or feasible in all Arctic Council member nations. Rather, they represent a menu of potential immediate and no-regrets measures, in accordance with the Tromsø mandate. The menu of potential measures contained herein do not represent a quantitative ranking that accounts for costs, or other factors that Arctic nations may wish to consider, such as total potential for emission reduction, potential Arctic climate benefit, and potential health benefits. It will be up to individual Arctic governments and their jurisdictions, and Council bodies, to determine which measures will provide the greatest national and Arctic benefits, in accordance with national circumstances and policy and legislative frameworks.

The Task Force would also note that many of these measures may be suitable for implementation by Permanent Participant members and other local communities, and may apply to Council Observer and other non-Arctic Council nations, particularly those at higher latitudes or engaging in near- or within-Arctic activities. Some of these actions may also prove beneficial to other glacier, snow and ice dominated regions of the world.

Measures to reduce black carbon from transport, especially diesel-powered , could include more retrofitting of older vehicles and equipment, retirement of old engines, vehicles and equipment, and enhancing or expanding current controls to the extent that PM standards are not in place.

On- and off-road diesel vehicles are a large source of black carbon emissions, and are already subject to regulation in all Arctic Council nations for emissions of PM. Most Arctic nations already have regulations for *new* on- and off-road diesel engines that are either in effect or will become active by 2020, and which require these vehicles to implement technologies that should reduce black carbon emissions by over 90% compared to pre-regulation engines. Early measures would therefore involve either more retrofitting of older and high-emitting vehicles and equipment, enhancing current controls on existing vehicles and equipment, or accelerating the timeline or broadening the scope of existing regulations for new engines. Such measures – all of which have strong health co-benefits – could include:

- Accelerated implementation of ultra low sulfur diesel (ULSD) requirements for both on-highway and non-road diesel fuels (an important prerequisite to black carbon reductions), accompanied by emissions controls to reduce diesel PM;

- Development and implementation of particulate emission standards, enforcing use of particulate traps, for new engines of on- and off-road vehicles, mobile machinery, locomotives and certain marine vessels where such standards may not be in place;

- Retrofitting existing older and high-emitting vehicles and equipment with particle filters through regulation or voluntary subsidy programs;

- Retirement or replacement of the dirtiest existing sources (especially those not easily fitted with filters) through regulation or financial incentives; Guidelines for early retirement or scrappage programs should ensure that the original engine is either destroyed or, when possible, returned to the manufacturer to be remanufactured to cleaner emission standards;

- Coordinated campaigns for better enforcement of new standards, more stringent inspection requirements, and encouragement of better maintenance practices;

- Introduction or expansion of "green zones" that ban or require special fees of vehicles with high particle emissions;

- Reducing truck and off-road idling through regulation, education, or rest stop electrification; additional vehicle efficiency programs; addition of auxiliary power units on non-road equipment, and use of smart transport algorithms.

Similar retrofit, retirement, or replacement measures could be applied to reduce black carbon emissions from stationary engines and equipment.

- This might apply to diesel generators in High North communities, especially indigenous communities solely dependent on such generators for electricity;

- Coordinated campaigns for better enforcement of new standards, more stringent inspection requirements, and encouragement of better maintenance practices.

Measures to reduce black carbon from residential heating could include standards, change-out programs, technologies for more efficient combustion and retrofits addressing wood stoves, boilers and fireplaces.

Wood stoves and boilers have emerged as a leading target for black carbon mitigation strategies, as they are a major source of black carbon emissions in the Arctic. Wood burning also produces emissions of methane and ozone precursors. Although some countries do regulate particle emissions from these stoves and boilers, control measures may not always capture black carbon emissions. Many homes in Arctic Council nations have transitioned from oil to wood over the past decade, a trend expected to continue. Many that do use wood are located in the more near-Arctic regions, and the emissions are therefore more likely to be transported to the Arctic. While planned stove replacement campaigns and particle emissions controls may reduce black carbon emissions in some areas, without new measures, overall emissions from this sector are projected to remain steady or increase by 2030. New technologies may enable highly effective mitigation measures to improve both health and climate. The following measures offer potential for reductions of black carbon emissions in this sector:

- Implementation of stringent black carbon emissions standards or stricter PM standards, regulations and inspection regimes for stoves and boilers;

- Development of point-of-manufacture certification programs for stoves and boilers meeting emissions and performance standards;

- Voluntary old stove/boiler change-out programs and incentives for newer models that emit less black carbon;

- Increased combustion efficiency;

- Boiler retrofits, for example with accumulator tanks;

- Operator education campaigns (best fuels and burning techniques).

To reduce black carbon from agricultural burning, prescribed forest burning and wildfires, measures could include demonstration projects for management alternatives to burning, prevention of accidental fires, and greater resources devoted to fire monitoring and prevention. When controlled burning is necessary, management techniques may help reduce emissions or limit their impacts.

Unlike the other key sources highlighted in this document, all forms of open biomass burning release much larger amounts of organic carbon compared to black carbon. Therefore, the contribution of these emissions to global warming may be unclear; however, because of the reflective Arctic surface, emission reductions of black carbon and organic carbon from

biomass burning reaching the Arctic are likely to help slow Arctic warming. Agricultural and forest fires also release significant amounts of CO_2, carbon monoxide, methane and other air pollutants.

Agricultural burning and prescribed forest burning appear to be a very significant source of black carbon in the Arctic. Depending on local conditions, alternatives to agricultural burning or prescribed forest burning may raise other environmental issues.

Wildfires are also a large emission source that will not always be subject to control. While in some regions these wildfires are primarily the result of lightning strikes, in other areas wildfires may begin as intentionally set fires that subsequently burn out of control.

Options for reducing black carbon from agricultural and forest fires include:

- Technical assistance (seminars, exchanges) and micro-financing assistance to foresters and farmers to encourage the use of no-burn methods (such as conservation tillage or soil incorporation);

- Demonstration projects and exchange of information to show the efficacy of no-burn methods, both bilaterally and as exchanges between national and sub-national governments of Arctic Council nations or organizations, and through joint Council projects;

- Development of fire management programs and strategies aimed at preventing accidental wildfires and avoiding unnecessary application of fire in land management. Information campaigns aimed at decreasing such fires may represent a relatively low-cost measure to decrease black carbon emissions;

- For controlled burns where necessary in forestry or agriculture, emissions may be decreased via more efficient and controlled burning techniques (e.g., central or consolidated locations, biochar) or through measures to control the timing of burns, enhance moisture, or encourage mechanical removal of material before the burn;

- Expand resources for fire monitoring, fire management decision support, and fire response.

Measures to reduce black carbon from <u>marine shipping</u> in and near the Arctic could include Council-wide adoption of voluntary technical and non-technical measures, [adoption of the proposed amendment of MARPOL Annex VI to establish an Energy Efficiency Index,] and collaboration with IMO on other certain actions.

Marine shipping in the region is a relatively small source of black carbon, yet potentially high in impact due to its proximity to snow and ice, and may increase significantly, due to projected increases in global ship traffic as well as decreases in summer sea ice cover. Shipping is also a significant source of the precursors that lead to higher levels of local ozone, impacting health as well as climate. The Arctic nations comprise 90% of current shipping activities in the region, and therefore have a unique ability to influence the development of future black carbon emissions from this sector by enacting early voluntary measures and engaging in international regulatory regimes such as the IMO:

- Voluntary measures by all eight Arctic Council nations to decrease black carbon emissions; and encouragement of vessels (especially cruise ships) flagged in non-Arctic Council nations and also operating in the Arctic to adopt these measures as well;

- Support by all eight Arctic nations of the current IMO submission on black carbon by Norway, Sweden and the U.S., which raised the importance of black carbon emissions from shipping on the Arctic climate, and identified a range of technical and operational measures (e.g., speed reduction, improved engine tuning, energy efficiency enhancements, better fuel injection, or use of diesel particulate filters);

- Support adoption by all eight Arctic Council nations of the proposed amendment of MARPOL Annex VI to establish an Energy Efficiency Design Index for new ships;

- Ongoing provision of new scientific and technical developments to the IMO by AMAP and other Council working groups, and vice versa.

For gas flaring, it is premature to identify specific black carbon mitigation options but increased research and better emission inventories are recommended to improve understanding of the significance of this source.

The significance of black carbon emissions from gas flaring remains highly uncertain, but is a source of potential concern in the High Arctic, especially as oil and gas activities expand. More effective methods to quantify black carbon emissions from flaring are currently being developed through, for example, a Canadian research effort involving Carleton University and Natural Resources Canada, and efforts by Norway to engage the oil and gas private sector. Resources should be made available to support such efforts. Oil and gas activities also constitute a very large Arctic source of methane emissions, and such studies could determine methane emissions and leakage in parallel to work on black carbon:

- Funding for immediate work on in-field measurements, scientific and technical analysis, in concert with the private sector, aimed at filling current information gaps;

- Obtaining better black carbon emissions data, as well as location and other basic information on flaring practices;

- Providing information on best practices and regulatory options from the energy industry where there has been progress in reducing flaring (e.g., Canadian provinces such as Alberta);

- Ensure coordination with other international efforts addressing venting and flaring, such as the Global Gas Flaring Reduction Partnership and Global Methane Initiative.

Arctic Council actions on black carbon mitigation offer an important leadership opportunity to promote near-term Arctic climate protection.

The Arctic Council countries have an interest in encouraging non-Arctic countries to reduce black carbon emissions because of the size and potential Arctic climate impact of these emissions from non-Arctic Council nations.

Some of the lessons learned in addressing black carbon can be exchanged between the Arctic Council, Council nations and other snow- and ice-dominated regions of the world that may also be impacted by black carbon emissions.

- As black carbon discussions expand in other forums, the Arctic Council can play an important leadership role by communicating the importance of action on black carbon; demonstrating application of appropriate control measures; and conveying the importance of near-term Arctic climate protection to other forums such as UNEP and UNFCCC;

- Enhanced collaboration with other SLCF efforts, such as those in CLRTAP and its various working groups, the IMO, UNEP and the UNFCCC should be pursued;

- Arctic Council Observer nations may have a special role in joining and cooperating in these outreach efforts, as well as participating in Council SLCF initiatives.

Future of Arctic Council Work on Short-Lived Climate Forcers:

The Task Force urges the Arctic Council and Council nations to carefully consider the findings and recommendations contained herein in order to help identify future priority work areas. The Task Force also recommends that the information contained herein be viewed in combination with other relevant information, such as the results from the AMAP Expert Group.

Because of the need to consider the near-term Arctic climate benefits of addressing all short-lived climate forcers, including methane and ozone, as well as the need to continue to improve our understanding of the black carbon mitigation measures that will have the greatest Arctic climate benefit, ***the Task Force recommends that the Arctic Council continue its work in this area***.

For black carbon measures, the Task Force has identified key areas that may require improved information to assist decision making by Arctic Council nations, such as the costs of implementing certain measures, the additional emission reduction potential of some measures, potential Arctic climate benefits, and potential health benefits.

Because scientific understanding of the role of SLCFs in the Arctic climate continues to evolve, and other bodies such as CLRTAP, UNEP and the UNFCCC have moved to address at least some of the SLCFs, the Task Force or other body should be charged with bringing to the Council appropriate updates and recommendations on a continual basis, as appropriate opportunities present themselves.

In addition, consistent with the Task Force's recommendations that Arctic Council nations gather and share information on black carbon, ***consideration should be given to mechanisms for facilitating the sharing of information on emissions, impacts, and mitigation options across Arctic Council nations. This information should also be made available to AMAP and ACAP or other Council bodies for their specific needs.*** In this regard, the Task Force also recommends that the Arctic Council nations consider improved engagement in the circumpolar black carbon demonstration project activities run by the ACAP Project Steering Group.

Although SAOs agreed the Task Force should initially focus on black carbon, ***methane and ozone may prove equally or perhaps even more important to efforts aimed at constraining climate change in the Arctic.*** Recent work by the UNEP Integrated Assessment on Black Carbon and Ozone, and LRTAP's Task Force on Hemispheric Transboundary Air Pollution, for example, both point to methane and ozone mitigation as having high potential to slow warming in the Arctic.

The Task Force also wishes to stress, in considering any future work on short-lived climate forcers under the Arctic Council, that methane is already well understood from a climate science perspective, and many key methane mitigation options have already been well characterized and demonstrated. Unlike the case for black carbon, emission inventories for methane are well advanced and reported under the UNFCCC with IPCC reporting guidelines.

Because of this strong starting point, plus ongoing methane mitigation efforts (e.g., whether under legal instruments such as the Kyoto Protocol or voluntary efforts such as the Global Methane Initiative), ***the Arctic Council and Council nations may be able to leverage these efforts to encourage additional methane reductions, both within and outside Arctic Council nations, by communicating and demonstrating the climate benefits of such measures specifically for the Arctic region.***

Because it is likely to require a greater policy focus in the future, and to enhance its ability to interact with other Council bodies such as ACAP, due consideration should be given to the need for the Task Force or other body to have a more policy-oriented membership, while maintaining strong ties with AMAP and the scientific community.