Summary of Mobile Source Policy Group Discussion
Workshop on Short Lived Climate Forcers
Chapel Hill, NC
March 3-4, 2010

In your view, is it possible to identify priority mitigation options in this sector for black carbon and ozone precursors, considering cost, technological feasibility, ease of implementation, and effectiveness? If so, what are they?

a) **Super emitters, proximal emitters and high growth emitters may be the low-hanging fruit both domestically and internationally**.
   i) Super emitters, which represent high emission from in-use vehicles, cause a disproportionate share of mobile source emissions.
      1) New on-road diesels in the United States have very low black carbon emissions due to strict PM standards. A possible issue with these diesels is to assure these diesels continue to meet strict emissions standards at higher mileages. Also, emissions characterization is needed at lower temperatures where PM emissions are usually higher. Some in the group thought that more stringent regulations are not needed for new on-road diesels. But, most participants agreed that stricter PM standards for non-road diesels (as well as commercial marine and locomotives) may be or are needed to reduce black carbon. Reductions in black carbon emissions will have climate benefits which will vary from area to area depending on the source and other conditions.
      2) The term super emitters was used as a generic term without specific definition. In general, it applies to on-road diesels no longer meeting the PM standards to which they were certified. EPA representatives commented in various forums that emission factor models (such as MOVES) accounts for these high emitters but some participants questioned if EPA emission data fully account for high emitters. The meeting participants conclude that they did not know what the public's palatability is for getting big emitters off the roads. There are potential implementation challenges.
      3) Engine replacements (including engine rebuilds) and turnover can remove dirtiest engines. Also, diesel retrofit programs can target older high emitting engines. But there may be no silver bullet.
      4) While on traditionally thinks of black carbon as coming from diesel engines, gasoline engines are also an important source and high emitters there can emit significant black carbon.
   ii) High emissions of BC near high albedo surfaces such as polar ice caps and desert surfaces, or where there is high transport to high albedo surfaces, will generate a warming impact that is magnified
      1) Proximal could be defined on both health and climate endpoints. A characteristic distance of 1000 km would define regions of strong health or climate impact.
      2) Spatially based inventories based on emission and usage data are needed to evaluate proximal emitters. This would only require scales rough enough to decide where to identify hotspots and calibrate work.

3) Preliminary data from Drew Shindell's modeling showed the effects of albedo and precipitation on total climate impact. For example, desert regions have bright surfaces and little rainfall, so the BC effect is stronger as it remains suspended longer in the atmosphere. North Africa and the Middle East were highlighted.

iii) Freight, aviation and shipping are high growth modes within transportation deserving special attention.
   1) Freight growth can be hidden because it is often folded into total road emissions.
   2) Aircraft are a large source of tropospheric ozone at high altitudes formed from HC/NOx emitted at higher altitudes. While methane is typically a better target for reducing ozone, aircraft are a unique source of ozone because of high altutide NOx emissions and the relatively clean atmosphere.
   3) Inventories show low amounts of BC emissions from aviation, but there is some question about the quality of these measurements.

How do the mitigation opportunities differ between world regions for this sector, considering the range of available options?

a) Outside the US, low-sulfur and new diesel regulations based on best practices in US and Europe are key

iv) Should also look at two and three-wheeled vehicles for conversion of gasoline 2-stroke engines to 4-stroke engines. Two-strokes are easy to construct and use, so the feasibility of this strategy is uncertain, but it should be evaluated. The evaluation should involve using 4-stroke cycle engines (preferably with catalytic type emission controls) for new two and three-wheeled vehicles as well as replacing 2-stroke cycle engines for in-use vehicles. The latter, of course, would be more difficult to implement.

v) The hurdle in China and some other countries for stronger emission controls mostly from diesel but also gasoline engines is the sulfur content of fuel (for both gasoline and diesel fuel). They did resolve the issue of lead in fuel, so there is precedent for fuel quality improvements. The time frame for moving to lower sulfur is still several years, but the climate benefit of BC reductions from this could provide an incentive to move more quickly.

b) Other world regions use strategies that may provide examples for reducing emissions

i) In Mexico City, rules limit the age and operation of older vehicles. These require that public transportation vehicles can't be older than 10 yrs. Personal vehicles older than 10 yr are subject to no circulation days. There are other restrictions on time of day.

ii) Fuel switching to non-diesel energy sources can reduce BC content of emissions. For example, CNG is widely used in Pakistan.

c) Climate models are getting better at modeling total aerosols and GHGs and can inform decisions about prioritization

i) Inventories alone do not capture albedo, transport, and other spatial effects that determine climate impact.

ii) Climate models tell us where emissions are transported internationally, including what goes to the Arctic, the Himalayas, etc. They provide added value.

Needs

d) **Need clarity in comparing control scenarios between sectors.**
   i) It is important to look across sectors at different source categories. We may find that some actions are not financially feasible or justified.
   ii) The group thought that with 90% confidence on what diesel PM does in the atmosphere, this is enough to know which actions will be useful within the transportation sector. But we do not know whether this is the best value per CO2-equivalent reduced. We can have directionally correct actions based on what the health and climate science tell us, but how do we know whether they are they cost-effective and should be prioritized over other actions. Could similar or better results be achieved elsewhere?
   iii) This does not reflect a fundamental limitation of models, but rather a decision about appropriate application of criteria.
   iv) We know that the health benefits of diesel PM reductions improve the cost-benefit ratio when incorporated with the value of climate benefits. We know the combined ratio is good.
   v) Models may be helpful in assessing value of health and climate benefits of controls on shipping emissions, especially in the Arctic where there is a strong snow albedo effect and emissions may grow substantially in the future. Health benefits are likely low in places where shipping emissions are far away from population centers.
      1) Even with reduction in sulfates that would generate warming, this may be mitigated in regions where surface albedo is high, such as the Arctic.
      2) Modeling can take such issues into account and tell us where to focus.

e) We need to better quantify sources and emissions of super emitters
   1) Colorado is doing remote sensing for emissions (LIDAR)
   2) The number of vehicles and their relative contribution to total emissions is needed. This indicates how many there are and how much are they being used.
   3) An evaluation of methods to quantify black carbon emissions from super emitters (both diesel and gasoline) would help.

f) Need to investigate the feasibility of inspections for in-use vehicles
   1) Some group members commented that it is unclear whether inspections in the US can be established federally, or whether this is a state action
   2) Trucks make up a share of high emitters that need to be addressed. Many states don't require inspections or they're very crude. Could lead to upgrade of equipment.
   3) 800 reporting line for smoking vehicles should be investigated. Unsure how well this works in California. Would this need to be implemented at the state level, or can there be a federal reporting line as well?

g) Need to investigate feasibility of incentive programs to clean up in-use emissions
   i) May not work, since owner may be required to pay more than the blue book value of the vehicle

h) **Need to improve inventories and activity data**
   i) The future inventories are more uncertain than present-day inventories.
   ii) These should make assumptions based on technologies in place, not just focus on emission standards. They should take into account GDI and its effect on future inventories.

iii) Given proximal emissions of shipping to ice and snow in the Arctic, work on shipping emissions in the Arctic is needed
iv) Aviation appears to be a small part of the inventory, but maybe this is because we haven't measured it well. Aviation is the largest growing source of mobile activity.
v) Need better emission factors and activity data for off-road sources.
vi) Although light-duty emissions of BC are relatively low, they could be a concern in the aggregate. Future growth in fleet size and VMT could magnify this impact. But also new technology such as GDI could increase the rate of PM emissions and the ratio of BC to OC emitted. GDI will be important for achieving new fuel economy standards.
vii) Need inventories of PM number, not just mass. Europe has a particle number standard now. Plus particle number is associated with the indirect effect.

i) Behavioral and demand management strategies can support technological strategies

i) Strong support for and transition to public transport.
ii) An educational campaign in the developed world could raise awareness of the carbon footprint of transportation and less carbon intensive modes such as electric bikes. Incentives could be established for being less of a polluter
iii) The CO2 benefits from switching modes are potentially high, but these can cause PM (and BC) tradeoffs. Emission control options for PM should be considered in these cases.
    1) If the switch is to a mode that utilizes high sulfur fuel, there could be a tradeoff in higher PM emissions, such as a switch from gasoline passenger vehicles to uncontrolled diesel transit buses.
    2) Shift of cargo from truck to rail may reduce regional PM but increase local PM exposure. We can concoct counter examples as well. These suggest asymmetries in exposure and importance of scale of analysis.
    3) Electrification of rail systems has been done successfully, but emissions from electric generation source must still be taken in to account.
    4) Where PM emissions may increase, an evaluation of fuel and technology options should inform decisions to avoid tradeoffs.

What next steps – analyses, data, assessments, summaries – represent the low hanging fruit for clarifying policy mitigation options? Considering efficacy, impacts, and benefits of mitigation options?

[The group did not have time for this question]

Immediate follow-ups to the workshop

[The group did not have time for this question]

Other issues and questions

j) What kind of policy and regulatory infrastructure is in place to deliver desired mitigation options?
    i) The Arctic Council is performing analysis of emissions inventory, technologies, practices, costs, and policy infrastructure.

ii) Policy infrastructure can vary by country. The United States has the Clean Air Act, which sets various standards and uses these as tools to achieve emission reductions
iii) Some sources of BC have their specific policy levers to pull, such as emission standards for mobile sources. But not all sources have a policy lever – think of open biomass burning.

Additional Discussion

1) Initial discussion prior to breakouts.
   a) Sulfate emissions are down from shipping. Same for diesel cars.
   b) Look at uncertainty in PM emissions. Look at suite of emissions from different mode types, especially uncertainty in BC and OC. Do we assume that inventories are correct?
   c) What are the criteria for choosing priorities?
   d) EPA relies on PM2.5. What is the degree of uncertainty and how does it affect policy decisions? Could focus on within source and among source uncertainties.
   e) The source-specific uncertainties relate to the size and mass of particles. All other uncertainties will affect all other sources as well.
   f) The greater uncertainty is with regard to choice of actions. We have greater confidence about climate impact and how to control sources than other sectors.
   g) Transition to public transport is big in Europe, but not here. There is a technology focus in the United States. The driver is air quality in cities more than climate.
      1) AQ includes other emissions – tires, brakes (usually not – particles are too big)