

**Summary of Source Test and Ambient Measurement Breakout Group
Discussion
Workshop on Short Lived Climate Forcers
Chapel Hill, NC
March 3-4, 2010**

1 What do we understand well in this issue area that can help inform the selection of mitigation strategies?

The need to quantify a variety of aerosol properties in source emissions and at receptors:

- Blackness-This is the most useful indicator of the potential to absorb light. It has long been used to identify highly polluting emitters by their black plumes or the darkening of filter material. Particles appear black when their absorption characteristics vary as λ^{-1} .
- Particle light absorption at different wavelengths ($\lambda=300$ to 900 nm). Some materials absorb at specific λ , such as suspended dusts, or at $\lambda^{->1}$, which appear brown in color and is termed “brown carbon.” A larger range of λ absorption measurements is needed at source and receptor samples to determine how brown carbon and suspended dust affect the radiation balance.
- Particle internal mixtures-BC and EC never occur alone. They are always mixed with OC as soot and sometimes with sulfates and nitrates. This mixture changes, and often enhances, their radiative properties.
- Particle number and size-Modern, well-controlled combustion systems often emit large numbers of ultrafine particles that grow and evolve with distance from the emission source.
- Hygroscopicity- Particle sizes and shapes change with the uptake of liquid water at high humidities and the evaporation at low humidities. Linear particle shapes often collapse into more spherical forms after humidification and drying.
- Particle shape. Long-chain aggregates have different scattering and absorption properties than more compact shapes, such as spheres.
- Volatility-BC is a highly absorbing substance that can collect organic vapors. The semi-volatile organic compound component changes with temperature and the partial pressure of these compounds surrounding the BC core.
- Particle density-This is needed to relate number distributions to mass concentrations.
- Particle index of refraction-Needed to calculate absorption and scattering
- Horizontal and vertical distributions-BC is a primary emittant and concentrations are often localized near high emitting sources.
- Real-world emission rates-The most common emission tests are for certification and compliance. The test methods, units testing, fuels, and operating conditions to not represent the range of emissions used in actual applications.

2 What do we not understand well in this issue areas; how might this uncertainty affect the selection of mitigation strategies; and can we place bounds on the magnitude and direction of this uncertainty?

- The largest uncertainties relate to source emissions which are the bases for emission inventories. Although visible, black plumes are good indicators of excessively-emitting sources, and prime candidates for control, many better controlled sources may emit non-visible amounts of BC that constitute a large amount of emissions when they are summed. Since current source test methods do not perform the appropriate sampling and analysis to relate emissions to atmospheric concentrations, they are not useful for this purpose. Even if they were modified to better address climate needs, there is no central location where emissions test data are collected, quality assured, and disseminated.
- There are still large disagreements among different BC and EC measurement methods. Although the results are usually correlated when more than one method is applied, measurement documentation is often insufficient to determine which methods were used for a specific source or ambient data set. Accuracy, precision, validity, and comparability are not well quantified for the large number of emitters and receptors that require characterization. The controlling uncertainty, however, may be due to the small number of sources tested and the gross assumptions made when assigning a BC source profile to a specific combination of equipment, fuels, and operating conditions.
- Better time resolution in ambient measurements is needed to understand the source zones of influence. Sharp spikes of 1 to 5 min indicate contributions from a nearby emitter, while more slowly varying concentrations indicate contributions from more distant emitters.

3 What research or analyses are needed to address these critical uncertainties?

- Existing data need to be collected into a data base with appropriate documentation for both source and receptor measurements. Guidance on instrument operation and documentation is needed as part of this collection.
- To the extent possible, existing source tests for compliance and certification should include some of the properties cited under question 1, where they are appropriate for the method. The sample blackness might be a starting point, as BC is relatively stable and is not believed to change as a result of sample heating and cooling, although the optical properties will change as a result of volatile compound condensation and evaporation.
- More versatile and real-world source test methods should be developed and applied in the long-term that could go beyond compliance to meet multiple monitoring objectives.

4 What immediate follow-ups to this workshop would you suggest?

- Establish a Wiki or data base where source emission tests, ambient data, source profiles, and other relevant data can be posted. This might begin with a draft guidance on data acquisition and reporting that could be enhanced by interested parties.
- Expand on the ideas in this summary, with appropriate citations to the literature and examples, to publish a policy-relevant article on data needs and the ability to meet them within time and budget constraints.

