Laboratory Evaluation of Black Carbon Aerosol Deposition onto Snow and Transport via Melting

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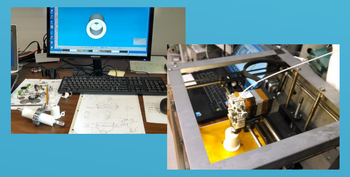
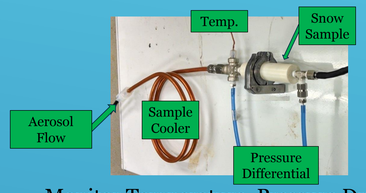
Procedure:

Question: How can we model the contact between BC carried in the wind and the snowpack?

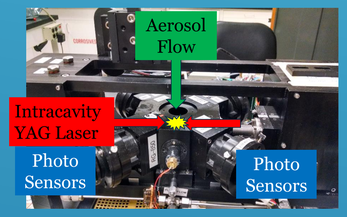


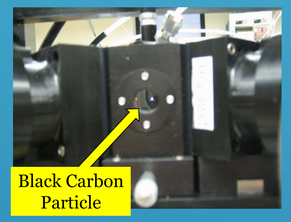
Design/Build a Sampling Fixture to provide uniform, controllable aerosol flow through the snow.



Monitor Temperature, Pressure Drop and Flow Rates. Minimize melting, sublimation, deposition, and condensation in the system.

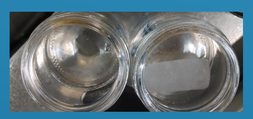
Question: When BC aerosol contacts snow, will BC preferentially pass through or deposit onto the snow?





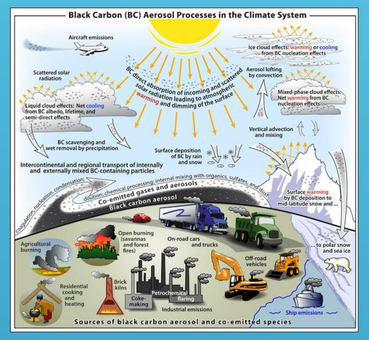
Measure BC Deposition onto Snow Using SP-2, (Single Particle Soot Photometer) Aerosol passes through a high power laser. BC particles absorb energy and glow. Sensors detect light emitted from the BC particles to measure the quantity and size of each particle.

Question: Is BC carried away with melt water, or is BC concentrated in the snow during melting?

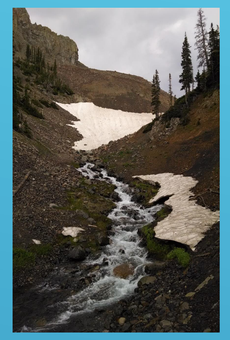


Compare BC concentration in meltwater and in remaining unmelted snow.

Background:



Bond, et al, JGR, (2013)



BC and other particles reduce reflectivity of snow.

Black carbon (BC) has been shown to be the second most important anthropogenic climate warming agent after carbon dioxide due to its ability to absorb solar radiation, influence cloud behavior, and accelerate snow melt. Because of its strong impact on snow reflectivity and rate of melting, more information is needed about the mechanisms controlling the deposition of BC onto snow. Also, in ambient testing, there have been conflicting results about the fate of BC in snow during melting. To address these questions, we have conducted measurements of black carbon aerosol deposition to snow and eventual removal in melting under controlled laboratory conditions.

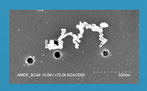


Image of a BC Particle
Source: NOAA

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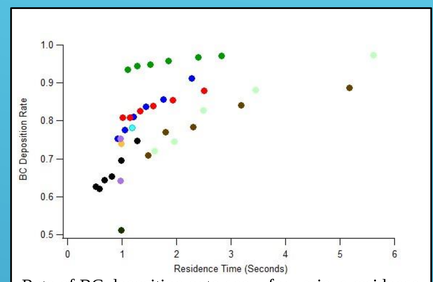
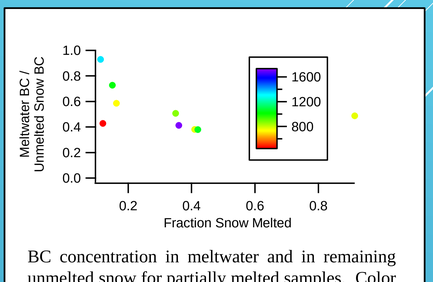
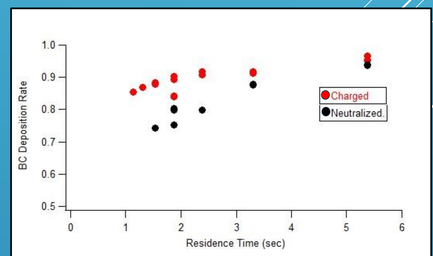
Results:



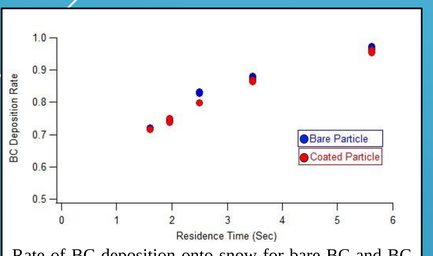
Rate of BC deposition onto snow for various residence times. Different colors represent different snow samples. A value of one would indicate that 100% of the incident BC was absorbed by the snow.



BC concentration in meltwater and in remaining unmelted snow for partially melted samples. Color gradient shows BC concentration of unmelted snow. Values less than one indicate a preference for BC to concentrate in the snow during melting.



Rate of BC deposition onto snow with and without a charge neutralizer to remove static charge on particles.



Rate of BC deposition onto snow for bare BC and BC coated with Ammonium Sulfate.

Our preliminary results indicate that BC interaction with snow can be reliably tested in laboratory conditions. Further study is needed to investigate the affects of particle size, coatings, electrical charges and snow grain size on deposition and meltwater transport.

Source:

Bond, T. C., et al. (2013), Bounding the role of black carbon in the climate system: A scientific assessment, Journal Geophysical Research: Atmospheres., 118, 5380–5552, doi:10.1002/jgrd.50171

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