The dark side of Brown Carbon

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Atmospheric aerosols are particles suspended in the air (e.g. dust, sea salt, soot). Depending on the aerosol's type and characteristics, aerosols can absorb or scatter the sunlight directly back into space. Aerosol radiative properties are one of the largest sources of uncertainty in calculations of the Earth's energy budget. Black carbon (BC) particles originated from combustion processes, are the second largest climate warmer after CO_2, and efforts have been done to reduce their emissions. More recently, "brown carbon" BrC (light-absorbing organic carbon) has attracted interest as a possible cause of climate change. Brc is known for its strong dependence of absorption on its wavelength, assumed to have strong absorption in the UV range, and zero absorption on the red visible range (650-780nm). However the definition of BC and Brc is operational and dependent on the measurement method.

One of the distinguishing features of BC, is its high absorption per its mass defined as the mass absorption cross section (MAC). The MAC of Black carbon <u>is a key input in radiative transfer models</u> and is confined in the literature to a relatively narrow range (7.5± 1.2 m^2g^{-1} at 550nm). This is in contrast to BrC which assumed to have a very low MAC (~1 m^2g^{-1} at 550 nm).

Here we question the clear distinction between Black and Brown carbon based on the mass absorption cross section. We show evidence from both flight (SEAC4RS NASA mission) and laboratory data (Montana fire facility; firelab), for the existence of a highly absorbing aerosol at 660nm, which has low volatility, but is not defined as BC by the traditional operational definition (as detected by the single particle soot photometer SP2). We term this material Dark Brown Carbon. This new finding may have major implication on global radiative models. The existence of dark brown carbon, would lead to overestimation of the BC role in global radiative forcing models, based on remote sensing measurements.