5.012 Investigating Black Carbon-Snow (“Dirty Snow”) Albedo Feedback in Climate Studies.

Early Career Scientist

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Abstract:

Black carbon (BC) has been identified as the second most important anthropogenic global warming agent by virtue of its strong absorption of solar radiation and significant reduction of snow albedo after its deposition. Observations have shown substantial and accelerating snow melting over high mountains and the Arctic associated with BC particles deposited on snow (“dirty snow”). Previous studies have investigated the effects of such factors as BC particle-snow grain mixing state, BC particle size, and snow grain size on BC-induced snow albedo feedback that accelerates snowmelt with global climate change implications. However, two critical features involving 1) BC-snow multiple internal mixing and 2) snow grain shapes have not been accounted for in evaluating the BC-snow interactions and feedback. In this study, we develop a physically-based parameterization that accounts for the two aforementioned features based on a stochastic snow model to quantify BC-snow albedo feedback. Our preliminary results show that BC-snow multiple internal mixing enhances snow albedo reduction by 40-60% compared with external mixing, while spherical snow grains enhances the albedo reduction by 20-40% relative to Koch snowflakes and hexagonal-plate snow grains. The parameterization will be further incorporated into a widely used land surface model (the Noah-MP model), where the aerosol-snow-radiation interactions and feedback are currently absent, to improve snow albedo simulations associated with weather and climate models on multiple scales. Similar parameterization will also be done to account for dust-snow albedo feedback in our future studies.