Effects of snow-darkening by absorbing aerosols on early spring snow melt and summer heat waves over Eurasia.

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Using the NASA GEOS-5 Earth System Model, we have carried out a series of 10 x10 years ensemble experiments to explore the impacts of snow-darkening effect (SDE), *i.e.,* surface albedo reduction due to deposition of absorbing aerosols (BC and OC) and dusts on the surface energy and water balance, and on extreme heat waves over Eurasia. Comparing the model climate with SDE to a control climate without SDE, we find that a) desert dust contributes the strongest SDE over eastern Europe/Western Asia region, while BC has maximum SDE over southwestern Europe, and northern East Asia, b) over the above areas, the maximum surface warming induced by SDE is 3–5°C near the snowline, during the spring melting season, c) ground wetness increases due to accelerated snowmelt during early to late spring, but subsequently decreases due to enhanced evaporation as land warms, and more exposure of bare land areas, as the snowmelt accelerates, and d) following the retreat of the snowline, the maximum surface warming migrates to northern Eurasia, while the continental land region continues to dry up through the following summer.

The continued drying of land and surface warming over Eurasia reduce tropospheric humidity, and suppresses cloud formation, leading to atmospheric blocking conditions, with increased geopotential height and anomalous anticyclonic circulation over Eurasia. The aforementioned sequence of SDE induced changes in water and energy cycles, and associated land-atmosphere interactions from boreal spring through summer eventually lead to a doubling of the frequency of top 10% hot days, and 10-fold increase in the frequency of the top 1% hot days in the summer months over western and northern Eurasia. Impacts of snow-darkening effect of Himalayan snowpack on the Asian summer monsoon will also be discussed.

Keywords: absorbing aerosols, snow-darkening effects, early snow melt and summer heat waves over Eurasia

