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Impacts of Snow Darkening by Light-absorbing aerosols on the Water Cycle over the Western Eurasia and East Asia

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In this paper, we have investigated the snow darkening effects by light-absorbing aerosols on the regional changes of the water cycle over the Eurasian continent using the NASA GEOS-5 Model with aerosol tracers and a state-of-the-art snow darkening module, the Goddard SnoW Impurity Module (GOSWIM) for the land surface. Two sets of ten-member ensemble experiments for 10-years were carried out forced by prescribed sea surface temperature (2002-2011) with different atmospheric initial conditions, with and without SDE, respectively. Results show that SDE can exert a significant regional influence in partitioning the contributions of evaporative and advective processes on the hydrological cycle, during spring and summer season. Over western Eurasia, SDE-induced rainfall increase during early spring can be largely explained by the increased evaporation from snowmelt. Rainfall, however, decreases in early summer due to the reduced evaporation as well as moisture divergence and atmospheric subsidence associated with the development of an anomalous mid- to upper tropospheric anticyclonic circulation. On the other hand, in the East Asian monsoon region, moisture advection from adjacent ocean is a main contributor to rainfall increase in the melting season. Warmer land-surface caused by earlier snowmelt and subsequent drying further increases moisture transport and convergence significantly enhancing rainfall over the region. This findings suggest that the SDE may play an important role in leading to hotter and drier summer over western Eurasia, through coupled land-atmosphere interaction, while enhancing East Asian summer monsoonal precipitation via enhanced land-ocean thermal contrast and moisture transport due to SDE-induced warmer Eurasian continent.

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