

Impacts of snow darkening by absorbing aerosols on South Asian monsoon

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North-south temperature reversal caused by the seasonal heating over the Tibetan Plateau is a main driver of the onset of the South Asian Monsoon. Aerosols can play an important role in pre- and early monsoon seasonal heating process over the Tibetan Plateau by increasing atmospheric heating in the northern India, and by heating of the surface of the Tibetan Plateau and Himalayan slopes, via reduction of albedo of the snow surface through surface deposition –the so call snow-darkening effect (SDE). To examine the impact of SDE on weather and climate during late spring and early summer, two sets of NASA/GEOS-5 model simulations with and without SDE are conducted.

Results show that SDE-induced surface heating accelerates snow melts and increases surface temperature over 4K in the entire Tibetan Plateau regions during summer. Warmer Tibetan Plateau further accelerates seasonal warming in the upper troposphere and increases the north-south temperature gradient between the Tibetan Plateau and the equatorial Indian Ocean. SDE-induced increase of the meridional temperature gradient drives meridional circulation and enhanced upper tropospheric easterlies and lower tropospheric westerlies, and intensifies monsoon circulation and rainfall. This pattern enhances the EHP-like circulation anomalies induced by atmospheric heating of absorbing aerosols over the northern India. The results suggest that SDE-induced early snow melting over the Tibetan Plateau may cause early and stronger monsoon in early summer.

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