

Effects of Absorbing Aerosols on Accelerated Melting of Snowpack in the Hindu-Kush-Himalayas-Tibetan Plateau Region

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Abstract (invited presentation)

The impacts of absorbing aerosol on melting of snowpack in the Hindu-Kush-Himalayas-Tibetan Plateau (HKHT) region are studied using in-situ, satellite observations, and GEOS-5 GCM. Based on atmospheric black carbon measurements from the Pyramid observation (~ 5 km elevation) in Mt. Everest, we estimate that deposition of black carbon on snow surface will give rise to a reduction in snow surface albedo of 2- 5 %, and an increased annual runoff of 12-34% for a typical Tibetan glacier. Examination of satellite reflectivity and re-analysis data reveals signals of possible impacts of dust and black carbon in darkening the snow surface, and accelerating spring melting of snowpack in the HKHT, following a build-up of absorbing aerosols in the Indo-Gangetic Plain. Results from GCM experiments show that 8-10% increase in the rate of melting of snowpack over the western Himalayas and Tibetan Plateau can be attributed to the elevated-heat-pump (EHP) feedback effect, initiated from the absorption of solar radiation by dust and black carbon accumulated to great height (~ 5 km) over the Indo-Gangetic Plain and Himalayas foothills in the pre-monsoon season (April-May). The accelerated melting of the snowpack is enabled by an EHP-induced atmosphere-land-snowpack positive feedback involving a) orographic forcing of the monsoon flow by the complex terrain, and thermal forcing of the HKHT region, leading to increased moisture, cloudiness and rainfall over the Himalayas foothills and northern India, b) warming of the upper troposphere over the Tibetan Plateau, and c) an snow albedo-temperature feedback initiated by a transfer of latent and sensible heat from a warmer atmosphere over the HKHT to the underlying snow surface. Results from ongoing modeling work to assess the relative roles of EHP vs. snow-darkening effects on accelerated melting of snowpack in HKHT region will also be discussed.