NCAP-COALESCE
CarbOnaceous AerosoL Emissions, Source apportionment & ClimatE impacts
Understanding scientific complexities related to carbonaceous aerosols focussing on issues underlying their origin and fate, and their role as drivers of regional climate change over India.

Research BRIEFS

Aerosol influence on surface temperature and snow melt in the Himalayan region.

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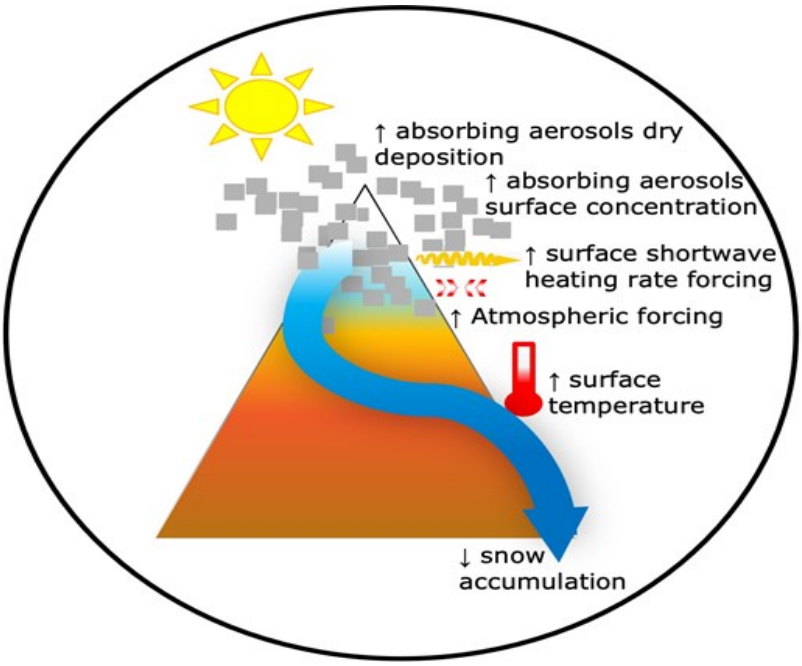

Key highlights:

- Multi-decadal ECHAM6-HAM2 simulations of aerosol radiative effects in the Himalayas.
- Increased concentrations & dry deposition of black carbon and dust aerosols.
- Increased surface aerosol shortwave heating rate forcing & temperature.
- Changes in the surface energy balance are linked to accelerated snow melting.
- Recent decades (1990-2010) show a prominence of these effects over earlier decades.

Summary:

In this study, the ECHAM6-HAM2 (atmosphere-only) general circulation model was used to study the impacts of aerosol radiative forcing on surface temperature and snow melt from 1971 to 2010 over INHR. The differences between present-day aerosol and low aerosol scenarios were investigated, in which enhanced BC and dust aerosols in the springtime were found to cause widespread warming of land-atmosphere and increased snowmelt in the INHR. The meteorological and aerosol fields such as BC, AOD, SCF and T-2 m are well reproduced by our model for the present-day aerosol scenario. The significant warming regions in the western and central Himalayas have shown higher presence of

absorbing aerosols than scattering aerosols. The surface concentrations of BC and dust are significantly greater in the present-day aerosol scenario (Figure 1). These absorbing aerosols have enhanced. These absorbing aerosols have enhanced radiative forcing at atmosphere and surface SWHRF The enhancement of absorbing aerosols throughout the atmospheric column could result in an increase in temperature and SWHRF vertical profiles. The surface SWHRF has a possible causal link to increased snowmelt rate, where surface SWHRF values were found to be higher compared to the values found in any other cases. Hence, we infer that the absorbing aerosols caused an anomalous atmospheric heat energy transfer to land, which may have resulted in springtime surface warming and melting of snow over Himalayas.

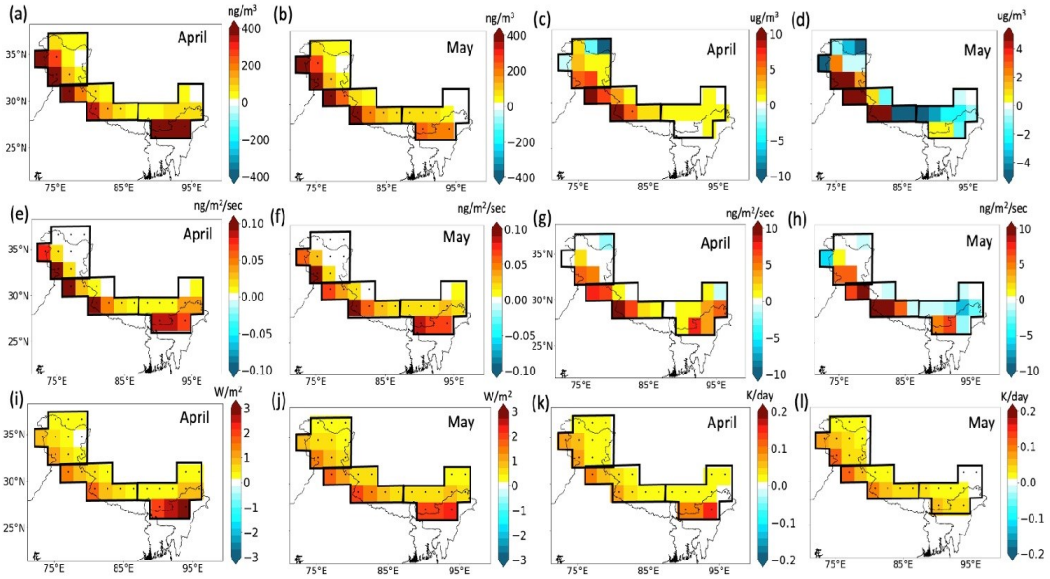

Figure 1: Spatial patterns differences of (a, b) surface BC concentration (ng/m^3); (c, d) surface dust concentrations (ug/m^3); (e, f) BC dry deposition flux (ng/m^2/sec); (g, h) dust dry deposition flux (ng/m^2/sec); (i, j) atmospheric radiative forcing (DARF-ATM) (W/m^2) and (k, l) surface shortwave heating rate forcing (SWHRF) (K/day) defined as the climatological monthly mean difference between present-day aerosol and low aerosol scenarios for the month of April and May. Black dots represent the statistically significant pixels at 95%.

Major findings :

- Snow cover acts a short-term water storage, provides water for drinking, agriculture and hydropower plants over Himalayas. Increasing temperature causes high snow melts and rapid changes in snow cover which has an impact on ecology as well as economical growth.
- Also, the increase in absorbing black carbon anthropogenic emissions can cause atmospheric-surface changes over Himalayas. Therefore, this study calls out for black carbon emission reduction policies to reduce rapid snow melting in Himalayas.
- Snow models needs better representation of aerosols to study the impact of aerosols over snow surfaces. Also, we need evidence of climate changes through in-situ measurements which are spatially and temporally dense.

Research Article

Citation

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