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

Absorbing aerosols affects high temperature extremes.

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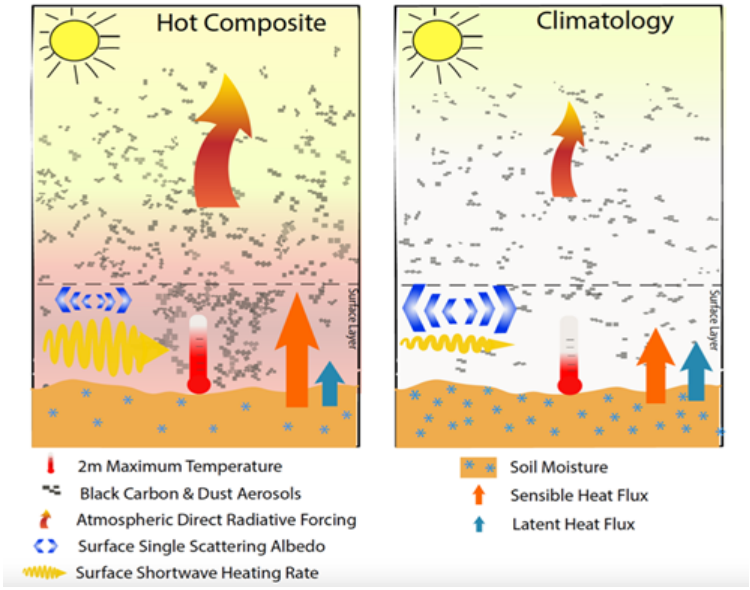

Key highlights:

- Comparison of hot composite and climatology using general circular model during pre-monsoon season.
- 30 year maximum temperature trend shows highest temperature in north western India.
- Absorbing aerosols abundances like black carbon and dust shows an increase during hot composite.
- Increases in surface layer absorbing aerosols concentrations causes increase in surface shortwave heating rate forcing in hot composite.
- Modulation of surface fluxes like latent and sensible heat by absorbing aerosols leads to high temperature extremes during hot composite.

Summary:

The Indian region is marked by an abundance of absorbing aerosols, such as black carbon (BC) and dust compared to other parts of the world. Meteorological conditions and enhancements of aerosols are linked to atmospheric temperature alterations. The absorbing aerosol from the incomplete combustion biomass fuels and agricultural biomass (Venkataraman et al., 2005) and can cause atmospheric warming (Ramanathan et al., 2002). GCM-based temperature projections for the Indian region is common (e.g., Basha et al., 2017; Mishra et al., 2017; Im et al., 2017), no study, to our knowledge, have thus far evaluated representation of synoptic-scale processes in GCM simulations, which influence heat wave conditions in India. The goal of this work was to understand the

and high-temperature extremes in north-central India during the pre-monsoon season. Simulations from 1981 to 2010, from the chemistry-coupled atmosphere-only ECHAM6-HAM2 GCM are used. A composite of high-temperature extremes in our model simulations shows anomalous anticyclonic conditions with positive geopotential height anomalies, enhanced subsidence and LTS, along with reduced cloud cover and increased solar radiative heating, identified in reanalysis observations in previous studies, during heat waves.

We found that absorbing aerosols are associated with pre-monsoon hot extremes in north-central India. The hot extremes in our GCM simulations concur with lowered single scattering albedo and enhanced BC-AOD and Dust-AOD, compared to climatological conditions, revealing abundance of absorbing aerosols. This resulted in positive anomalies in atmospheric radiative forcing and surface shortwave heating rate, during the hot extremes. The surface energy balance showed simultaneous decrease in latent heat flux, but an increase in sensible heat flux.

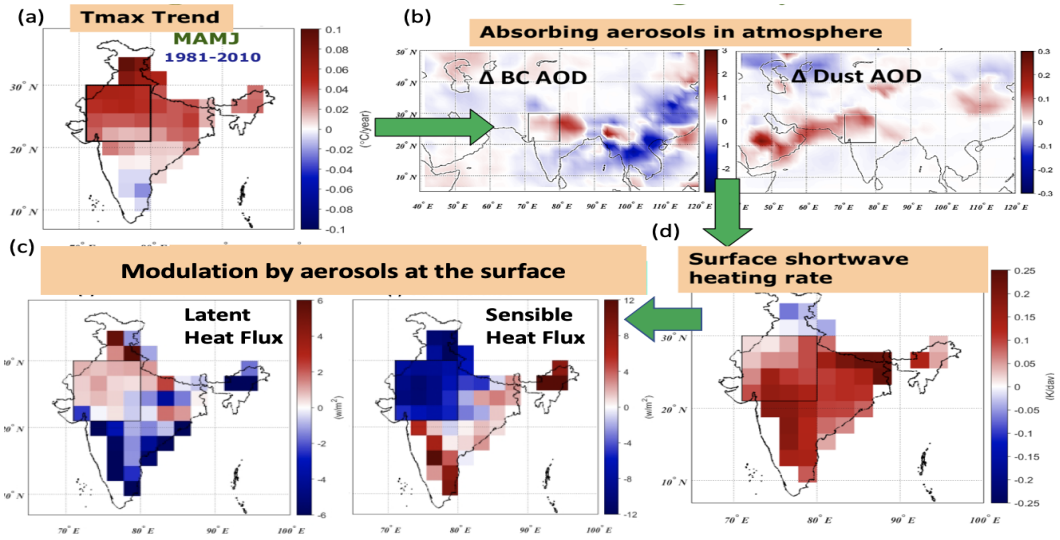

Figure: (a) Thirty-year (1981-2010) trends (°C/year) in maximum temperature in the pre-monsoon season; (b) Composite anomalies of black carbon (BC) and dust (DU) aerosol optical depth (AOD); (c); surface flux (latent and sensible heat flux) differences between hot composite and climatology (d) surface shortwave heating rate difference between hot composite and climatology

Major findings :

- To our knowledge, this may be one of the first studies to link high-temperature extremes in India to increased abundances of absorbing aerosols (BC and dust), through an enhancement in shortwave heating rate, and alterations in surface heat fluxes, consistent with enhanced surface temperature. This is in contrast to sulfate aerosol-induced cooling reported in most other world regions.
- Our results emphasize the importance of regional forcings such as those from absorbing aerosols on the climate system, particularly in regions which may experience rising emissions of atmospheric forcing agents such as GHGs and aerosols.

Research Article

Citation

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