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 radiative feedback enhances particulate pollution over India: A process understanding

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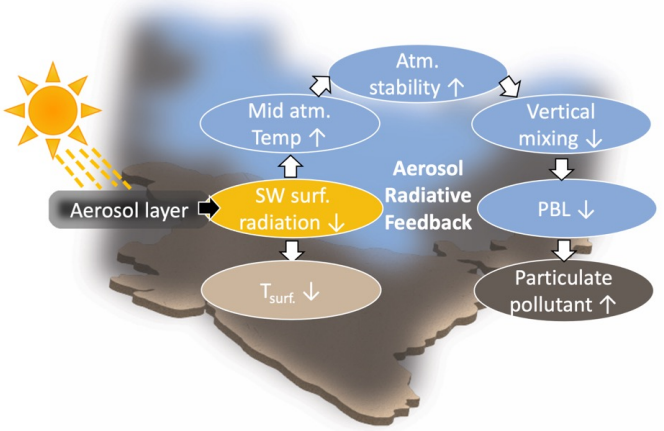

Key highlights:

- Online coupled WRF-Chem simulations was analysed to investigate aerosol direct effect.
- Direct effects reduced radiation, temperature and PBL height, annually and seasonally.
- $PM_{2.5}$ levels increased due to ADE where primary aerosol concentrations were dominant.
- The effects reduced O_3 in most of the regions, due to high levels of NO_2 and SO_2.
- $PM_{2.5}$ levels due to ADE has implications on estimation of premature mortality.

Summary of your Research:

The impacts of the aerosol radiative effect on $PM_{2.5}$ and its constituents, as well as precursor gases and ozone, via changes in meteorology and atmospheric chemistry in India, are investigated. Using a pair of simulations with WRF-Chem for an entire year over India (2015), with and without the aerosol radiative effect coupling to meteorology, to evaluate the effects on particulate pollution levels and their implication for premature mortality. For meteorological variables, the model could competently reproduce the observations.

For $PM_{2.5}$, the model performance was bounded within NMB of -0.1 from an extensive database of observations, indicating considerably better performance than reported in earlier studies for this region. This results from the combined benefits of a regionally representative emission inventory optimised dust boundary conditions and meteorological data assimilation. Underlying mechanisms include reduction in surface-reaching solar radiation, increased atmospheric stabilisation and consequent reduction in planetary boundary layer height and ventilation and thus an increase in particulate pollutant levels. Sub-regional level changes in annual average $PM_{2.5}$ surface concentrations from aerosol radiative feedbacks found here in India were larger than those in other world regions but similar to those in haze episodes, indicating the importance of the aerosol radiative effects in enhancing $PM_{2.5}$ in regions of high aerosol loading.

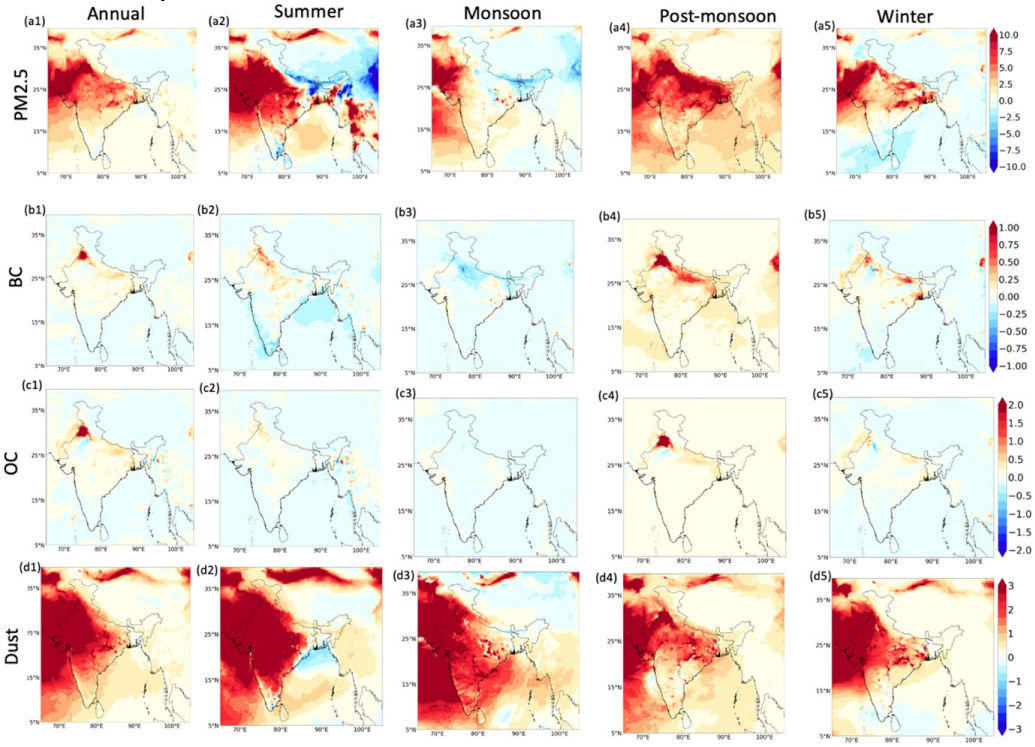

Figure 1: Spatial distribution due to aerosol radiation interaction (BASE - NoARI) to surface concentrations of: (a1-a5) $PM_{2.5}$, (b1-b5) black carbon (BC), (c1-c5) organic carbon (OC), and (d1-d5) dust, for annual and seasonal mean of 2015.

Take away/conclusion :

- We find that in the polluted north-western and IGP regions, aerosol direct radiative effects significantly enhance surface-level particulate pollution and related premature mortality. This is of particular concern, with expected future increases in regional emissions.
- These findings suggest the importance of using fully coupled meteorology-chemistry models, rather than one-way meteorology-driven chemical transport models, to analyse air pollution in the Indian region to account for ARI enhancements of surface air pollution and its effects.

Research Article citation

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