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

An Analysis of the Aerosol Lifecycle Over India: COALESCE

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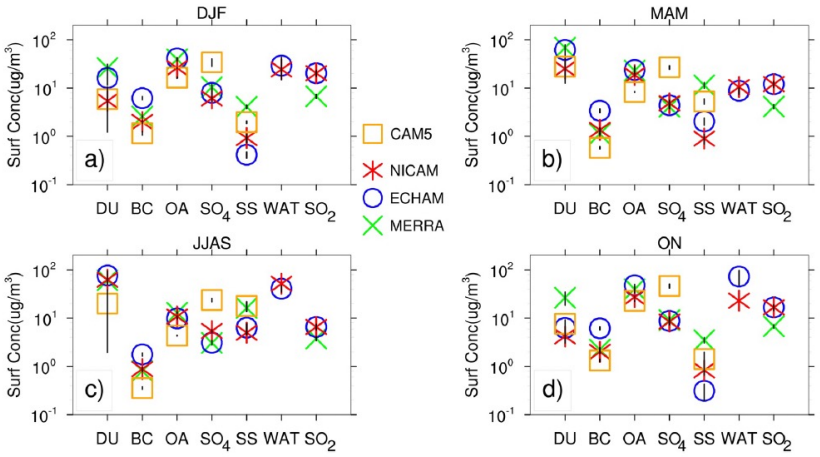

Key highlights:

• Simulated aerosol mass improves from use of a regional emissions inventory, organic aerosol to carbon ratio and dust tuning

• Model improvements are needed in estimation of vertical mass flux, secondary nitrate and organic aerosol

• Larger carbonaceous aerosol residence times and AOD fraction over India, than global estimates, result from larger regional emissions

Summary of your Research:

Atmospheric aerosols or atmospheric particulate matter affects climate variables like temperature and rainfall, agricultural productivity, soil, and human health. We evaluated aerosol lifecycle over India via simulations (2005–2014) from three general circulation models under the COALESCE project (carbonaceous aerosol emissions, source apportionment, and climate impacts; Venkataraman et al., 2020, 10.1175/bams-d-19-0030.1). The ECHAM6.3-HAM2.3, CAM5.3,

and NICAM-SPRINTARS simulations use identical regional emissions (from the Speciated Multi-pollutant generator, SMoG-India-v1). Satisfactory model simulations of meteorological variable magnitudes and seasonal cycle have been achieved partly from the adoption of nudging. Estimations of anthropogenic aerosol, aerosol optical depth (AOD), and particulate matter surface concentrations are significantly improved from (a) dust tuning, (b) use of satellite-derived organic aerosol to carbon ratio, and (c) nudged meteorology to capture variables influencing the production of secondary sulfate. Larger wintertime under prediction (−30% to −60%) results from over prediction of seasonal planetary boundary layer height and the absence of secondary ammonium nitrate and organic aerosols. Vertical dispersion to higher altitudes than in observations calls for improved modeling of vertical mass flux representation.

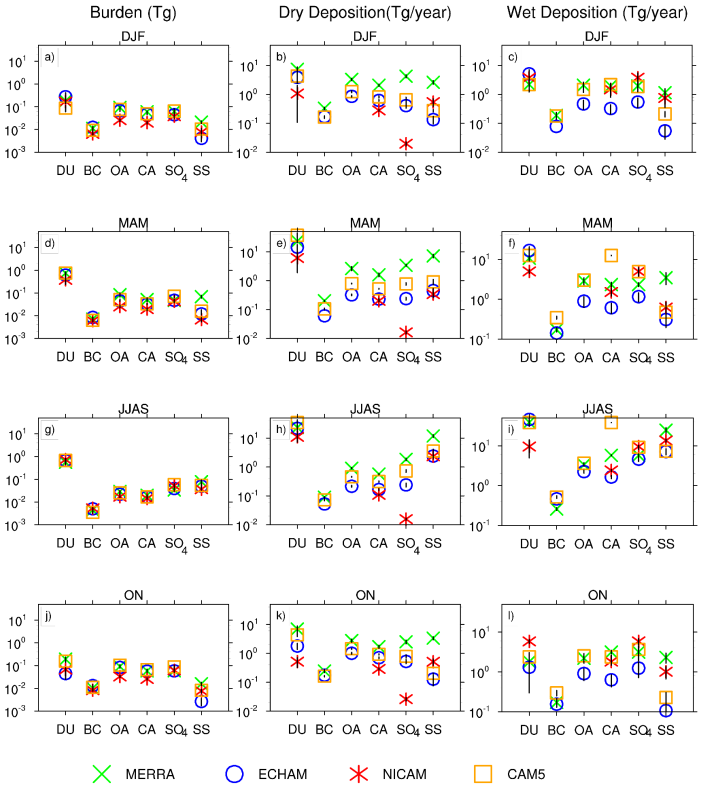

Figure 1. Seasonal variations of burdens and wet and dry depositions of different species. Seasonal (winter: DJF, pre-monsoon: MAM, monsoon: JJAS, post-monsoon: ON) mean (a,d,g,j) burden (Tg), (b,e,h,k) dry depositions (Tg/year) and (c,f,i,l) wet depositions (Tg/year) of DU, BC, OA, CA, SO_4, SS simulated by three models and MERRA-2 data over Indian Landmass. The black lines show year-to-year standard deviations of individual species simulated by each model.

Take away/conclusion :

- Larger carbonaceous aerosol predominance over India is driven by larger emissions. This manifests in larger regional residence time of carbonaceous aerosols compared to their global mean values. Further, carbonaceous aerosol AOD, as a fraction of total AOD, ranges 15%–40% over the Indian region and is larger than global mean values, with a seasonal predominance in autumn and winter seasons.
- This has implications for aerosol radiative forcing and possible warming in terms of temperature response in the Indian region, which runs contrary to consistent aerosol cooling in other world regions.

Research Article citation

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