Research BRIEFS

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.

The possible indirect effect of dust aerosols during monsoon breaks over India.

Arya, V.B., Surendran, S. & Rajendran, K.

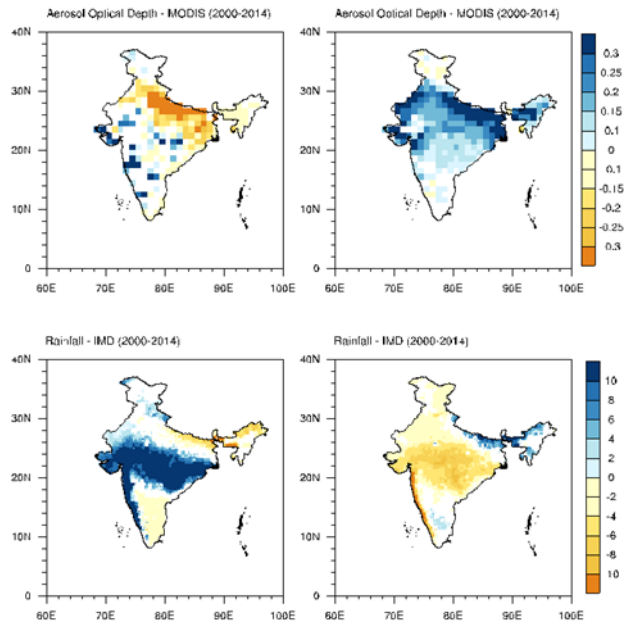

Figure1:(a) Top panels: Composite anomalies of AOD during active (top-left) and break (top-right) phases of monsoon.(b) Bottom panels: The same as (a), but for rainfall during active (bottom-left) and break (bottom-right) phases. The anomalies statistically significant 95% confidence level are shaded.

Key highlights:

- Active (break) spell of summer monsoon is found to be associated with lower (higher) aerosol optical depth over India.
- The build-up of desert dust transported to India by prevalent circulation during summer monsoon breaks, is associated with lower cloud effective radius which indicates the indirect effect of aerosols.
- Predominant indirect effect induced by dust aerosols along with secondary semi-direct effect can lead to further rainfall reduction during intense and persistent breaks.
- Proper incorporation of dust aerosol induced heating during breaks in models, is essential for simulation of intraseasonal-variation inherent to Indian summer monsoon and thereby improving its prediction.

Summary:

Dust aerosols can act as CCN and participate efficiently in cloud processes during the active phase. During breaks, significant buildup of dust aerosols over India, which are transported from Africa, west Asia, and Thar desert by the large-scale circulation, is associated with lower cloud effective radius (CER) implying aerosols' indirect effect where they can inhibit cloud growth (low cloud optical thickness) in the presence of reduced moisture and decrease precipitation efficiency/rainfall. For breaks, there is a clear inverse relationship

between AOD and rainfall which appears to imply the possibility of the aerosols reinforcing the breaks under increased loading. In validation, the correlation between intraseasonal, 20-100-day band pass filtered anomalies of AOD and rainfall during monsoon, shows significant negative correlation when AOD leads rainfall by ~ 3-5 days, over most parts of India. The magnitude of correlation implies that the indirect impact of aerosols on rainfall through clouds is effective during the break spells, albeit they are not the primary factor responsible for the breaks. Shortwave flux (SWF) at top of the atmosphere (TOA) is found to be less during composite break spells indicating the interaction of the long range transported dust aerosols with SWF which in turn implies its semi-direct effect. This also reveals that during long breaks, dust induced semi-direct effects could also be effective in addition to the indirect effect. These results are crucial as breaks are permanent features of ISM and it is essential to incorporate dust-induced feedbacks in models for proper simulation of ISV and thereby improved prediction of ISM.

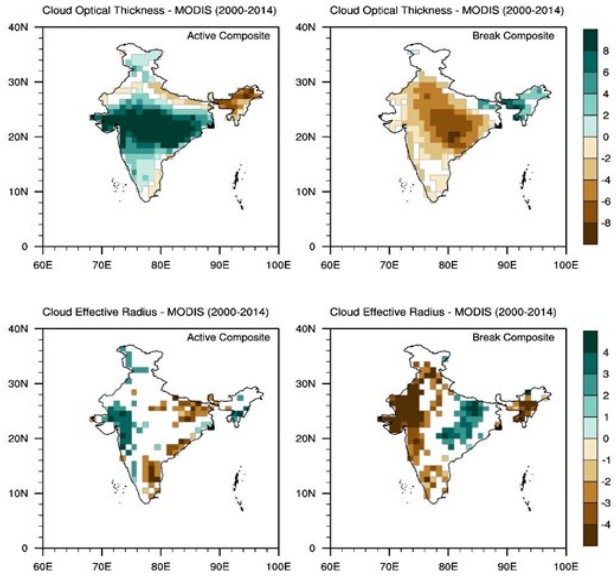

Figure 2. Fig: (a) Top panels: Composite anomalies of COT during active (top-left) and break (top-right) phases of monsoon. (b) Bottom panels: The same as (a) but for CER during active (bottom-left) and break (bottom-right) phases. The anomalies statistically significant at 95% confidence level are shaded.

Major findings :

- Dust aerosols can act as CCN and participate efficiently in cloud processes during the active phase. During breaks, build-up of desert dust transported by prevalent circulation, is associated with lower cloud effective radius implying aerosols' indirect effect where they can inhibit cloud growth in the presence of reduced moisture and decrease precipitation efficiency/rainfall.
- The correlation, albeit small, between intraseasonal anomalies of AOD and rainfall is negative, when AOD leads rainfall by 3–5 days implying that indirect aerosols impact is effective during breaks, though it is not the dominant responsible factor.
- During breaks, lower shortwave flux at top of atmosphere hints at dust-induced semi-direct effect.

Research Article

Citation

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