Indian Institute of Tropical Meteorology

Press Release (27.10.2025)

Reducing Global Air Pollution Levels Could Increase Summer Monsoon Rainfall in India, New Study Finds

Key Highlights:

- **Transboundary Climate Impact:** The study demonstrates that aerosols are a major climate risk factor with effects spanning continents. Pollutants emitted in industrialized nations have a tangible impact on monsoon strength in distant regions.

- **Intensified Monsoon Rainfall:** A significant reduction in anthropogenic aerosol emissions over North America and Eurasia is expected to lead to an increase in summer monsoon rainfall over all the monsoon domain in the northern hemisphere - the Sahel, East and South Asia, and North America.

- **Need for Global Cooperation:** The findings assert that because air pollution has global consequences, mitigating its risks will require enhanced transboundary cooperation. Developing effective air pollution policies must account for these far-reaching climatic effects.

IITM Pune: A new study reveals that reducing air pollution in the Northern Hemisphere's industrialized continents could have a significant and far-reaching impact on future monsoon rainfall. The research, published in *Environmental Research Letters*, finds that aerosols from North American and Eurasian continents play a substantial role in shaping monsoon precipitation, and that a drastic decrease in these pollutants will likely intensify summer monsoons in West Africa, North America, and South Asia.

The study, led by Dr. Sooraj K. P. of the Indian Institute of Tropical Meteorology (IITM), Pune, addresses a critical challenge in climate science. While it is known that air pollution from human activities, particularly aerosols, has greatly influenced past monsoon patterns, predicting future changes has been difficult. This research provides crucial insights, suggesting that efforts to improve air quality could have unintended climatic consequences thousands of miles away.

Uncovering the Climatic Role of Aerosols

Aerosols, which are tiny particles suspended in the atmosphere, originate from both natural sources, like dust storms, and human activities, such as burning fossil fuels. These particles can powerfully impact the climate by scattering and absorbing sunlight, and modifying cloud

properties. For decades, high levels of aerosol pollution from industrialized regions in the Northern Hemisphere have masked some of the warming caused by greenhouse gases, while also altering large-scale atmospheric circulation patterns that govern monsoon systems.

This new research investigates what might happen in a future in which current trends in aerosol burdens persist – decreases over the industrial regions of North America, Europe and East Asia, but an increase over South Asia. As many nations implement clean air policies, the reduction in aerosols will lead to change in climate far beyond the source regions. The study explores how this signal propagates through the climate system and influences the powerful monsoon systems across the Northern Hemisphere.

Insights from Earth System Models

To explore this complex relationship, the research team analysed a suite of advanced climate models from the Detection and Attribution Model Intercomparison Project (DAMIP). They studied a future moderate emissions scenario in which anthropogenic air pollution is drastically reduced over the United States, Europe, and East Asia, consistent with current trends.

The models showed that the reduction in aerosols leads to a significant increase in the energy input into the Northern Hemisphere's mid-latitudes causing warming of the landmasses. This warming strengthens the surface and tropospheric thermal contrast, i.e., the temperature difference between the northern and southern hemispheres. A stronger thermal contrast invigorates the cross-equatorial atmospheric flow, pulling more moisture from the tropical oceans towards the northern continents and resulting in more intense monsoon rainfall over West Africa and South Asia.

Details of the Study

- **Title:** Future intensification of Northern Hemisphere monsoons due to declining remote aerosol pollution
- **Authors:** K. P. Sooraj (IITM), Chirag Dhara (Krea University), D.C. Ayantika (IITM), Kalik Vishisth (IITM), K. M. Sumit (IITM), A. G. Turner (University of Reading), R. Krishnan (IITM)
- **Journal:** *Environmental Research Letters*
- **Link to the study:** https://iopscience.iop.org/article/10.1088/1748-9326/ae0f41

For any media query, contact:
Ayantika Dey Choudhury, Indian Institute of Tropical Meteorology, Pune, INDIA.
Tel: +91 9850616906, E-mail: <ayantika@tropmet.res.in>

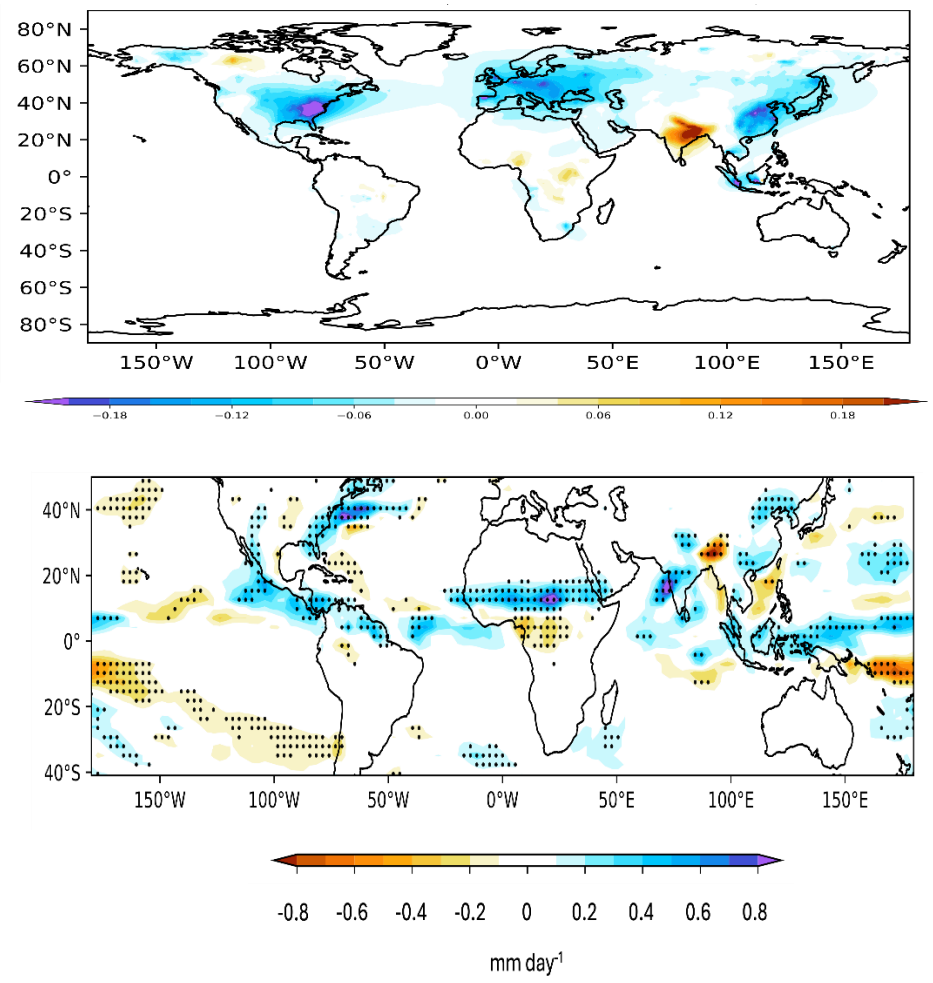

Figure: Projected mid-21st century change in aerosols (Top panel, 550nm AOD) and precipitation (Bottom panel, mm/day) during the Indian summer monsoon season (JJAS). Results are shown for the MIROC6 model. Figure adapted from this paper *(i.e., Sooraj et al 2025).*

****