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Observing changes of India's summer monsoon

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The United Nations' Intergovernmental Panel on Climate Change (IPCC) has reported an increase in the frequency and intensity of heavy precipitation events globally, primarily driven by human-induced climate change. The South and Southeast Asian Monsoon, particularly over India, is one of the affected regions, which has experienced significant changes in precipitation patterns. Characterized by a seasonal reversal of wind and rainfall, the Indian summer monsoon is driven by land-sea thermal contrasts and atmospheric dynamics influenced by the Himalayas, the Tibetan Plateau, and the Indian Ocean. Recent studies attribute the increased intensity of the monsoon to higher sea surface temperatures and enhanced atmospheric moisture fluxes.

Observational data and climate models indicate a general trend of increasing monsoon rainfall, although with regional variability, alongside simultaneous rises in dry spells and extreme rainfall events. Between 1951 and 2015, localized heavy rainfall events have become more frequent, while moderate rainfall events have declined, leading to more severe droughts in central India. Since the 1990s, monsoon rainfall has exhibited an upward trend, consistent with projections of enhanced land-sea thermal contrasts and warming in the Indian Ocean.

In this study, satellite-based climate datasets, such as those provided by EUMETSAT's H SAF and LSA SAF, were used to analyze monsoon dynamics. Key indicators like precipitation, soil moisture, and vegetation coverage revealed complex interactions between rainfall, surface temperature, and evapotranspiration. While the short-term period from 2008 to 2020 shows variability without clear long-term trends, notable correlations emerged, such as increased rainfall leading to cooler temperatures and enhanced soil moisture. Conversely, warmer temperatures had mixed effects on vegetation, moderated by factors such as water availability and land cover.

The observed trends align with global patterns of climate change, with both thermodynamic and dynamic processes contributing to extreme events. Future projections suggest a stronger summer monsoon and a weaker winter monsoon as global warming intensifies, driven by anthropogenic forcing and enhanced land-sea thermal contrasts. These findings highlight the intricate interplay of climatic drivers and underscore the growing need for monitoring and adaptation in response to a changing monsoon regime.