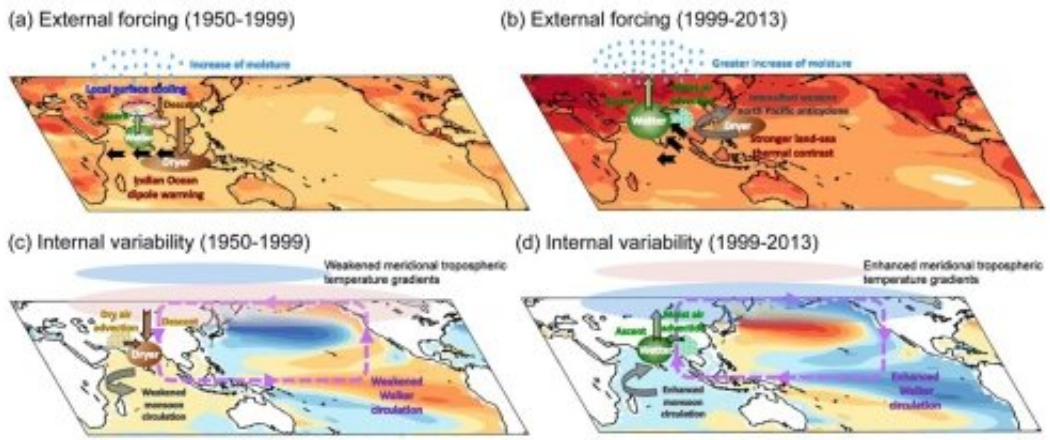
India's 50-year drying period and subsequent reversal—battle between natural and anthropogenic variability

June 12 2020, by Li Yuan



Schematic diagrams showing how external forcing and internal variability affect the recent decline and recovery of ISM rainfall, respectively. Credit: IAP

A billion people rely on rainfall from the Indian summer monsoon (ISM). Its variability may produce impacts both locally and globally. Understanding the variability is essential to make effective adaptation planning for future events.

The variability manifested itself in a decline in monsoon rainfall over north central India starting in the 1950s, which persisted for as long as five decades before a reversal from 1999 onward. Nailing down the predominant reasons for the decline and recovery has been vexing

scientists ever since.

Dr. Huang Xin and Prof. Zhou Tianjun from the Institute of Atmospheric Physics (IAP) of the Chinese Academy of Sciences have been examining the issue more closely using data provided by the UK Met Office and Germany's Max Planck Institute. Their findings, published in *Journal of Climate*, have examined the differing trends in pre- and post-2000 ISM rainfall.

"We found that neither the five-decade-long decline before 2000 nor the subsequent increase can be solely explained as a response to external climate forcing," said Huang. "Instead, we have demonstrated the crucial role of natural variability."

External forcing includes changes in greenhouse gasses, anthropogenic aerosols, and land use, etc. Natural variability refers to variations in the mean state due to internal processes within the climate system. They are often regarded as "signal" and "noise" in climate studies, respectively.

"Increase of greenhouse gas concentrations in the atmosphere generally tends to increase rainfall over India. Up to the year 2000, however, it appeared that the natural variability had been able to override this effect, resulting in the overall decrease," said Huang. "In addition to anthropogenic climate change, rainfall changes in recent decades are also influenced by natural sea surface temperature oscillation over Pacific basin."

The prominent natural variability in Pacific sea surface temperature on decadal-multidecadal timescales is usually described as the Interdecadal Pacific Oscillation (IPO).

Positive IPO phases are characterized by a warmer than normal sea surface in the tropical central-eastern Pacific and cooler than normal

conditions outside of the tropics with an opposite pattern during negative IPO phases.

The scientists found that the differing phases of the IPO played subtle, but crucial supplementary roles in the recent interdecadal variations of the ISM rainfall. Fluctuations in the IPO induced anomalous thermal contrasts between the north and south and changes to ascent and descent throughout the region. These, in turn, resulted in changes to the horizontal advection, from the west and east, of moisture into India.

Before 2000, the observed negative-to-positive IPO phase transition appeared to have decreased the externally forced rainfall trend. After 2000, the accumulative impact of external forcing and the positive-to-negative IPO transition has contributed to the observed wetting trend. The combined influences of the external forcing and IPO explained the observed rainfall changes. "This suggests, besides the forced 'signal," that we can actually extract useful information from the apparent, natural 'noise,'" said Huang.

The study supports, and brings together, for the first time, many of the different explanations that have been proposed in previous studies.

More information: Xin Huang et al. The Recent Decline and Recovery of Indian Summer Monsoon Rainfall: Relative Roles of External Forcing and Internal Variability, *Journal of Climate* (2020). DOI: 10.1175/JCLI-D-19-0833.1

Provided by Chinese Academy of Sciences