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Asian summer monsoon variability, global teleconnections, and dynamics during the last 1,000 years

Mayank Shekhar [a], Anupam Sharma [a,*], A.P. Dimri [b], Sampat Kumar Tandon [c]

[a] Birbal Sahni Institute of Palaeosciences, 53 University Road, Lucknow 226007, India
[b] School of Environmental Sciences, Jawaharlal Nehru University, New Delhi 110067, India
[c] Indian Institute of Science Education and Research, Bhopal, Madhya Pradesh 462066, India

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ABSTRACT

The Asian summer monsoon is a major regional phenomenon that drives and regulates precipitation over the Asian subcontinent. Understanding monsoon dynamics is a fascinating research question that reveals spatio-temporal variations in a variety of settings. The present study is based on previously available proxy data in order to get a better understanding of monsoon behaviour and associated physical processes, as well as their dynamics at annual scales. Several in-phase and out-of-phase links have been discovered in Asia during the last 1000 years. The present syntheses reveal evidence of the Medieval Climate Anomaly (MCA) and the Little Ice Age (LIA) during 1003–1210 C.E. and 1312–1730 C.E., respectively, that are otherwise distinct from the polar regions. In addition, the Asian monsoon shows a weaker trend during the LIA and relatively stronger during the MCA. Furthermore, the LIA event in Asia was shorter and weaker than the one in the Arctic and subarctic regions. Similarly, tree-ring isotopic data shows that monsoon activity has decreased in the Indian Himalayan Region (IHR) during the last several decades, whereas mean annual precipitation has increased in Tibet. Furthermore, the Atlantic Multi-decadal Oscillation (AMO) and North Atlantic Oscillation (NAO) show strong correlations from 1049 to 1995 C.E., but the El Niño-Southern Oscillation (ENSO) has emerged as the most influential driver for the Asian monsoon in recent decades, according to comparisons and global teleconnections analyses. The association of the monsoon with AMO and ENSO, as well as the Pacific Decadal Oscillation (PDO), has to be investigated further using multiple proxies, such as tree-ring, speleothem, and pollen, etc., so that future monsoon forecasts for the Asian region become more accurate. The monsoon is constantly changing and shifting, affecting the size and frequency of floods and droughts in the region. As a result, for monsoon modelling and prediction, the current synthesis on monsoon variability, as well as annual variation in contemporary and historical archives, is important. Furthermore, it has larger implications not just for the region's enormous population's fresh water and food security but also for the management of hydro-geomorphology-based natural disasters such as floods, landslides, and droughts, which pose a threat to life and property across Asia.

1. Introductions

The word "monsoon" refers to the seasonal reversal of predominant surface winds, which is marked by regional-scale atmospheric-land-sea temperature contrasts. The regional climate variability is ultimately controlled by the differential spatiotemporal variation in solar radiation and the associated seasonal contrast in precipitation, particularly in the Asian region (Kutzbach, 1981; Prell and Kutzbach, 1987; Huffman et al., 1997; Webster et al., 1998; Yihui and Chan, 2005; Cruz et al., 2006; Trenberth and Shea, 2006; Wang et al., 2008; Wang et al., 2012; Jalihal et al., 2019). Apart from the Asian region, the monsoon system occurs in other continents such as Australia; equatorial continents such as north-west and south-west Africa; and north and south America, which are referred to as the Asian–Australian monsoon system, the West African monsoon system, and the American monsoon system, respectively. In terms of intensity and circulation properties, each system is unique (Wang et al., 2014). The Asian monsoon is the world's largest monsoon system, with two subsystems: the Indian or South Asian Monsoon and the East Asian Monsoon, (Tao and Chen, 1987; Chen et al., 1991; Ding, 1994; Preethi et al., 2017). East Asia has the ocean to the east and the Tibetan Plateau to the west, while South Asia has the ocean to the south and the Tibetan Plateau to the north, (Wang et al., 2014).

* Corresponding author.
E-mail address: anupam110367@gmail.com (A. Sharma).

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