

A novel East Asian Summer Monsoon index reconstructed from a mixed approach and the multidecadal variability revealed in 1400-1900s

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The East Asian summer monsoon (EASM) is a distinctive component of the Asian climate system due to orographic forcing. Unlike Indian summer monsoon which occurs within the South Asian monsoon trough and presents a uniformity of rainfall distribution allowing for an All Indian Rainfall index to measure its variability, the definition of the EASM intensity has been much more complicated. One of the main reasons is the extensive domain of the EASM encompassing tropics, subtropics and midlatitudes and thus the complex space and time structures making it difficult to quantify the EASM variability. Despite the challenges, studying the evolution of EASM over hundreds or thousands of years is essential to build a comprehensive understanding on the monsoon behaviors and their associations with the general circulations. Hence, many previous studies have used geochemical proxy records from oceanic sedimentary or continental archives to build paleo-EASM indices by depending on mostly rainfall information retrieved from the records at some sites. The sort of the methods inevitably faces the issue of spatial coverage and limited explanatory power for the overall EASM.

In this study, we present a novel approach to reconstruct a paleo-EASM index. First, the current observational Western North Pacific monsoon index (Wang et al. 2008, in *Journal of the Climate*) approach was used to calculate the wind fields (zonal and meridional winds at 850hPA) from 1950 to 2020 using ERA5 data and rainfall data from NOAA Precipitation Reconstruction over Land to construct the modern EASM index and to examine the relationships between the rainfall and circulation anomalies. Then, the EASM rainfall pattern was projected to the gridded REACHES (Reconstructing East Asian Climate Historical Encoded Series) (Wang et al., in *Scientific Data*) historical climate index data between 1400 and 1900s. Thus, the reconstructed REACHES EASM index considers both temporal and spatial variability. In addition, the REACHES EASM index was further examined by overlaying the data with extreme events such as flood and drought from social archives. Therefore, the indication of the dominate large-circulation is able to be investigated at the multidecadal to centennial scale at the historical time.