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Climate Indices of Extreme Rainfall in the South Asian Monsoon Domain using a Bayesian Hierarchical Model

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Intraseasonal variability of extreme rainfall events (EREs) during the South Asian Summer Monsoon season is modulated by the Boreal Summer Intraseasonal Oscillation (BSISO), a convective system of organised heavy rainfall that moves periodically from the Indian Ocean to the Western Pacific over the subcontinent. The BSISO, in turn, is typically characterised using indices obtained from the leading components of an Empirical Orthogonal Analysis (EOF) of outgoing longwave radiation (OLR) and lower and upper troposhere wind data from the region [1]). A primary motivation for using OLR and wind data is that the EOF-analysis is not well suited for heavy-tailed data such as precipitation.

Here, we propose to estimate climate indices directly from EREs in the South Asian Summer Monsoon by applying the Hidden Climate Index (HCI) - framework introduced by Renard et al. (2022) [2]. The method is designed to work with binary, event-like data and utilizes a Bayesian hierarchical model incorporating spatial Gaussian process priors, to capture spatial and temporal interdependencies by sampling from a Bernoulli distribution.

Using the HCI framework, we estimate latent variables that underlie the ERE dynamics in the South Asian Monsoon domain, and show that these are related to large-scale modes of climate variability., We demonstrate that the ERE-based HCIs correlated well to the BSISO and in addition, we find relationships between the observed large-scale spatial ERE patterns to the El Nino Southern Oscillation and the Silk Road Pattern.

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