



Characteristics of compound flooding along the Indian coastline: Seasonal and interannual variability

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The Indian coastline, flanked by the Bay of Bengal and the Arabian Sea, is prone to the impact of intense low-pressure systems, specifically tropical cyclones and monsoon depressions and lows, which are accompanied by extreme rainfall and storm surges. The vulnerability of the Indian coastline to compound flooding, characterized by concurrent occurrence of extreme rainfall with extreme storm surge (SS-RF) or extreme rainfall with extreme sea level (SL-RF), poses a significant challenge in the face of changing climatic conditions. Analysing the past changes in the characteristics of compound flood events is essential to understanding the changing flood risks associated with concurrent extremes along the Indian coastline. This study utilises hourly sea level data from 8 tide gauge stations operated by Survey of India and daily rainfall data at those stations prepared from 0.25° gridded rainfall product of the India Meteorological Department (IMD). The skew surge time series corresponding to the stations are prepared by harmonic analysis of sea level data, and daily maxima of the time series which represent storm surge are analyzed. The concurrent extremes are identified as events where extremes of rainfall, sea level, and skew surge exceeded their respective 95th percentile thresholds concurrently. Our findings reveal distinct seasonal patterns, with higher occurrences of extreme sea level-rainfall (SL-RF) and extreme storm surge-rainfall (SS-RF) events during the summer monsoon (June to September) and post-monsoon (October to December) seasons along the east coast. Conversely, along the west coast, there are negligible SL-RF events throughout the year and the SS-RF events are clustered in the summer monsoon season only. The variability in frequency and intensity of concurrent extremes is higher in the post-monsoon than in the summer monsoon season along the east coast. The interannual variability of compound extremes on the east coast is primarily influenced by the El Niño Southern Oscillation (ENSO). During El Niño conditions, a decreasing trend in the frequency and intensity of concurrent extremes is observed, while La Niña conditions contribute to an increasing trend. ENSO impact also extends to the frequency and intensity of tropical cyclones during the post-monsoon season, also contributing to the interannual variability of concurrent extremes. The findings underscore the complex dynamics of the compound flood risk along the Indian coastline and provide valuable insights for assessing and managing flood risk under changing climate.

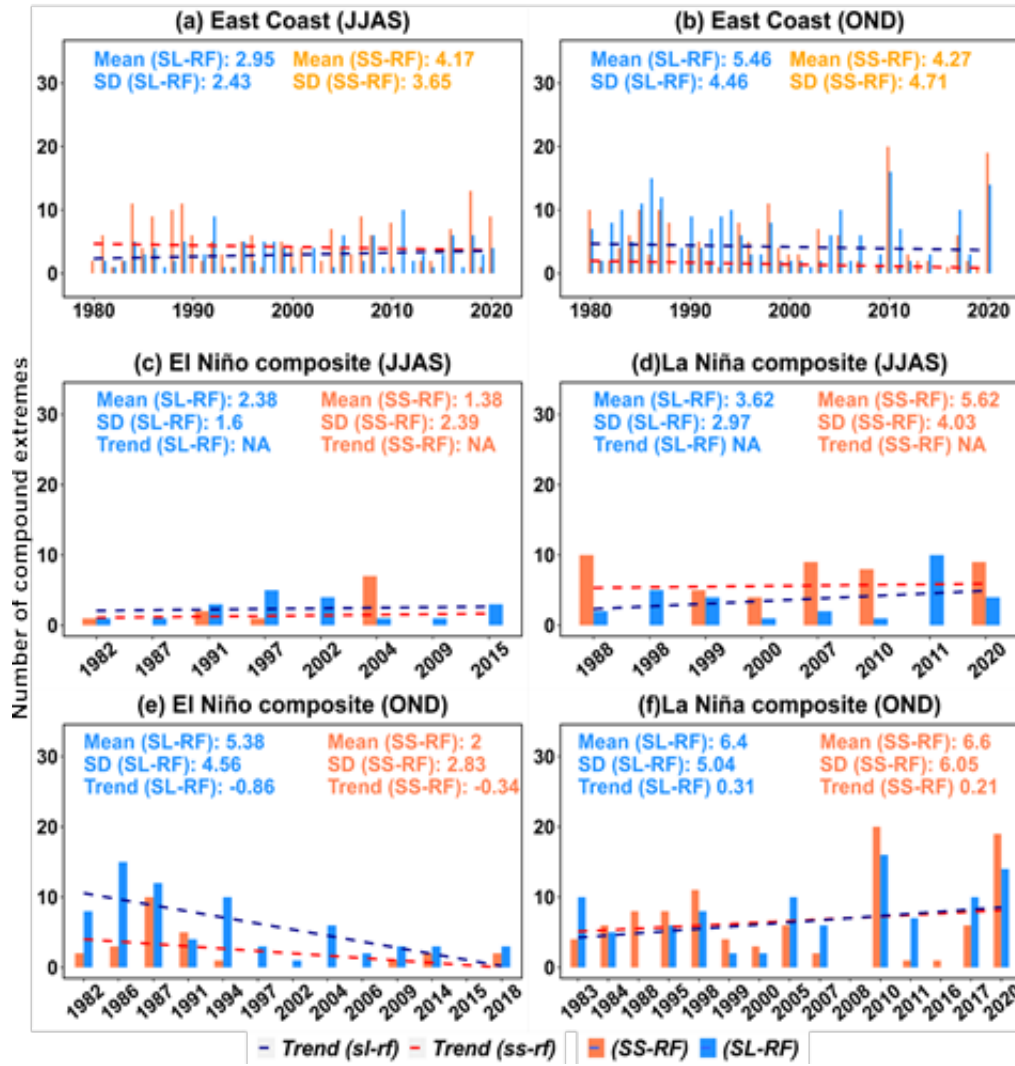


Figure 1: The number of compound extremes witnessed at typical locations along the east-coast of India during (a) the summer monsoon (JJAS) and (b) post-monsoon (OND) seasons. The El Nino and La Nina composite of the frequency of compound extremes are plotted for JJAS in (c), (d) and for OND in (e), (f).