## ABSTRACT

Drought arises from prolonged precipitation deficits that disrupt the hydrological cycle—a process increasingly amplified by climate change, which accelerates evaporation and intensifies both dry periods and extreme rainfall events. Conventional drought indices (Standardized Precipitation Index, SPI; Standardized Precipitation Evapotranspiration Index, SPEI) rely on the monthly aggregates of meteorological variables, thereby completely ignoring their intra-monthly distribution and spell/frequency characteristics. However, this should be critically questioned under the present scenario of climate change, where extreme short wet spells and extended dry periods are increasing agricultural and socioeconomic risks.

To address this gap, this work introduces the Standardized Net-Precipitation Distribution Index (SNEPI), which integrates daily net-precipitation distribution over multiple scales. It outperforms traditional indices—especially at longer time scales—by more accurately capturing increased dryness in arid regions and wetness in humid areas under shifting precipitation regimes. The study also quantifies divergence between SPI, SPEI, and SNEPI over time. It reveals that SNEPI identifies monsoon-season dryness missed by SPEI, and that divergence between SPEI and SPI aligns with changes in shortwave radiation, while divergence between SPEI and SNEPI corresponds to altered wet-spell patterns, notably in tropical zones. Globally (1951–2016), drought frequency quadrupled; drought probability increased by 60% even in surplus-rain years, with a 40% rise in tropical droughts driven by precipitation variability.

Focusing on the Indian monsoon, analysis highlights the influence of the Northern Arabian Sea low-level jet (LLJ). From 1951 to 2022, LLJ core drying (≈17% saturation deficit increase) and weakening (≈5% wind speed decrease) show strong correlation—with a two-day lag—to monsoon-season dry extremes. This shift in LLJ dynamics significantly increases the frequency, duration, and intensity of drought events. The findings emphasize the importance of incorporating precipitation distribution into operational drought indices, particularly in rapidly changing tropical climates.