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A new methodology for fitting time-varying distributions to hydroclimatic extremes using data assimilation techniques

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Research over the last couple of decades has shown that climate change is expected to modulate the frequency and magnitude of hydroclimatic extremes, leading to critical economic and environmental consequences in many regions around the globe. In light of this, statistical methodologies that do not rely on the commonly used assumption of stationarity have received great attention in analyzing extremes and future risk. Although in most cases such approaches improve the statistical representation of the historic hydroclimatic data, a clear limitation is that they require assuming a form of distributional change to describe temporal changes in statistics of extremes (e.g., linear change in the location or scale parameters of the Generalized Extreme Value distribution), making predictions highly dependent on this assumption and at risk of overfitting.

Here we propose a new methodology to fit time-varying distributions in hydroclimatic series, without the need of predefining the parametric form of change over time. Rather, using a data assimilation framework, our method adaptively and non-parametrically estimates the distributional changes of the series based on the likelihood of the data. Application of our method in both synthetic and historical data series demonstrates its competitive advantage in terms of predictive potential, relative to existing approaches.