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# Revealing the Structure of Precipitation Extremes: a spatio-temporal Wavelet Approach

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In the BMBF-funded ClimXtreme CoDEx project, we use advanced data compression techniques to analyze and characterize high-dimensional spatio-temporal weather extremes. By reducing the number of degrees of freedom, we improve the signal-to-noise ratio, facilitating a more precise assessment and detailed characterization of extreme weather events.

Here, we present a novel approach using wavelet decomposition to capture and analyze the complex spatio-temporal characteristics of precipitation extremes. Wavelet decomposition has proven to be highly effective in uncovering underlying frequency structures in time series data and is well-suited for analyzing two-dimensional patterns. Previous applications to spatial precipitation fields demonstrate their benefit for a better understanding and improved description of precipitation events.
We extend these methods to capture both spatial and temporal characteristics, providing a comprehensive description of three-dimensional precipitation fields across space and time.

We show that this approach is effective in capturing the diverse spatio-temporal features of precipitation extremes, enabling a more targeted and nuanced description of processes driving extreme weather phenomena. Our applications include comparisons of various datasets for their their representation of extreme precipitation events, with a focus on high-resolution data such as radar observations and simulations on convective-permitting scales. We also analyze and describe recent precipitation extremes in Germany, including the May/June 2024 flooding in southern Germany and the Ahr flooding in 2021.

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