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Wavelet Entropy Energy Measure (WEEM): A multiscale measure to grade a geophysical system's predictability

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Model-free gradation of predictability of a geophysical system is essential to quantify how much inherent information is contained within the system and evaluate different forecasting methods' performance to get the best possible prediction. We conjecture that Multiscale Information enclosed in a given geophysical time series is the only input source for any forecast model. In the literature, established entropic measures dealing with grading the predictability of a time series at multiple time scales are limited. Therefore, we need an additional measure to quantify the information at multiple time scales, thereby grading the predictability level. This study introduces a novel measure, Wavelet Entropy Energy Measure (WEEM), based on Wavelet entropy to investigate a time series's energy distribution. From the WEEM analysis, predictability can be graded low to high. The difference between the entropy of a wavelet energy distribution of a time series and entropy of wavelet energy of white noise is the basis for gradation. The metric quantifies the proportion of the deterministic component of a time series in terms of energy concentration, and its range varies from zero to one. One corresponds to high predictable due to its high energy concentration and zero representing a process similar to the white noise process having scattered energy distribution. The proposed metric is normalized, handles non-stationarity, independent of the length of the data. Therefore, it can explain the evolution of predictability for any geophysical time series (ex: precipitation, streamflow, paleoclimate series) from past to the present. WEEM metric's performance can guide the forecasting models in getting the best possible prediction of a geophysical system by comparing different methods.