



Different stages of the East Asian Summer Monsoon in the Holocene

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Paleoclimate proxy reconstructions (e.g. from lake sediments, ice cores, or stalagmites) have inherent age uncertainties resulting in a time-ordered series of correlated probability distributions rather than a precisely measured time series. Correlated errors make it challenging to analyze and extract valuable climate information from such records.

We show how (a) dynamical recurrences can be estimated in the presence of correlated noise, and (b) the modularity of recurrence networks can be used to infer dynamical transitions. We demonstrate our approach with a simple model and apply it to two isotope records from China to identify dynamical transitions of the East Asian Summer Monsoon (EASM) in the last 9000 years. Our results suggest that the Holocene EASM proceeded in four consecutive stages, becoming abruptly weaker at around 6400, 4400 and 3000 years ago. These transitions are known from earlier studies as abrupt, dry periods of weak monsoon superimposed on a long-term trend of gradual monsoon weakening. However, our results indicate that these events are critical shifts between four basins of stability of the Holocene EASM. We propose that these shifts could be triggered by small changes in the rate of solar insolation, which are then amplified by regional feedbacks.