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Detecting Climate Transitions with Recurrence Plots: A Case Study of the Younger Dryas

Biomarker records from lake sediments provide valuable insights into paleoclimate and its transition. This study focuses on n-alkanes (C27, C29, C31), biomarkers derived from plant waxes, and preserved in lake sediment cores. These compounds serve as proxies to reveal paleoclimate conditions.

Biomarker time series from two nearby sediment records, are compared to reconstruct the climate transitions during the Younger Dryas event. In this research, we use lake sediments proxy records from a modern lake and a paleolake in Poland, which were connected with each other. To better capture the phase transition in proxy data, the three compounds (C27, C29, and C31) are combined as components of a reconstructed phase space representing the dynamics of the proxy system. A key challenge is defining and quantifying shared paleoclimate transitions across these records.

To address this, recurrence-based techniques, specifically recurrence plots (RP) and joint recurrence plots (JRP), are applied to analyze and compare the dynamics of the two systems. These methods reveal similarities and differences in the temporal evolution of the paleoclimate. In particular, the joint recurrence plot presents intervals of shared dynamical behavior between two records, allowing to quantify the timing and duration of the Younger Dryas transition.

This study demonstrates how recurrence methods can be applied to paleoclimate proxy data to better characterize regional patterns of abrupt climate events such as the Younger Dryas.

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