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Recurrence Plot based entropies and their ability to detect transitions

K. Hauke Kraemer^{1,2}, Norbert Marwan¹, Karoline Wiesner³, and Jürgen Kurths¹

¹Potsdam Institute for Climate Impact Research, Research Domain 4, Potsdam, Germany (hkraemer@pik-potsdam.de)

²University of Potsdam, Institute of Geosciences, Potsdam, Germany

³University of Bristol, School of Mathematics, Bristol, UK

Many dynamical processes in Earth Sciences are the product of many interacting components and have often limited predictability, not least because they can exhibit regime transitions (e.g. tipping points). To quantify complexity, entropy measures such as the Shannon entropy of the value distribution are widely used. Amongst other more sophisticated ideas, a number of entropy measures based on recurrence plots have been suggested. Because different structures, e.g. diagonal lines, of the recurrence plot are used for the estimation of probabilities, these entropy measures represent different aspects of the analyzed system and, thus, behave differently. In the past, this fact has led to difficulties in interpreting and understanding those measures. We review the definitions, the motivation and interpretation of these entropy measures, compare their differences and discuss some of the pitfalls when using them.

Finally, we illustrate their potential in an application on paleoclimate time series. Using the presented entropy measures, changes and transitions in the climate dynamics in the past can be identified and interpreted.