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Natural time analysis for seismicity

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Natural time, kai, is defined by kai = k/N, as an index of the k-th event in a time series comprising N events, implying that the time proceeds when an event takes place. If the analysis of a time series representing the evolution of a complex dynamic system is carried out in this new time frame, one can recognize the time when the system approaches critical state, which is hard to do otherwise. The approach occurs when the variance of natural time becomes approximately equal to 0.070. Here, we summarize the theoretical background and empirical evidence for the validity of this condition in a variety of dynamical systems. Specifically, upon considering the Seismic Electric Signals (SES) and earthquakes as critical phenomena, natural time analysis on seismic catalogues makes it possible to identify the approach time of the critical state, which was empirically found to precede the occurrence time of the concerned main shock by a few days. This seems to be, as of now, the only promising method for short-term earthquake prediction using seismological data.

Keywords: Natural Time, Seismicity, Critical phenomena