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Record-Breaking Avalanches in Driven Threshold Systems

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Record-breaking avalanches generated by the dynamics of several driven nonlinear threshold models are analyzed. Such systems are characterized by intermittent behaviour, where slow buildup of energy is punctuated by an abrupt release of energy through avalanche events which usually follow scale invariant statistics. From the simulations of these systems it is possible to extract sequences of record-breaking avalanches, where each subsequent record-breaking event is larger in magnitude than all previous events. In the present work, several cellular automata are analyzed among them the sandpile model, Manna model, Olami-Feder-Christensen (OFC) model, and the forest-fire model to investigate the record-breaking statistics of model avalanches which exhibit temporal and spatial correlations. Several statistical measures of record-breaking events are derived analytically and confirmed through numerical simulations. The statistics of record-breaking avalanches are also compared to that of record-breaking events extracted from the sequences of independent identically distributed (i.i.d.) random variables. It is found that the statistics of record-breaking avalanches for the above cellular automata exhibit behaviour different from that observed for i.i.d. random variables which in turn can be used to characterize complex spatio-temporal dynamics. The most pronounced deviations are observed in the case of the OFC model with a strong dependence on the conservation parameter of the model. This indicates that avalanches in the OFC model are not independent and exhibit spatio-temporal correlations.