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WD model: a forest fire model considering weather influences

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In the traditional forest fire model (DS model), introduced by Drossel and Schwabl in 1992, the lightning probability f is constant and the burning tree spreads the whole cluster in a single time step. The system can involve to a self-organized critical state. The frequency distributions of fire size and fire interval follow a power law and an exponential law respectively. But with the real data in Japan, we found that the frequency-interval distribution of actual forest fires is not exponential, but a power law with periodical fluctuations about one day. In order to explore the reason for the temporal power-law distribution of forest fires, we study a weather driven model (WD model) built based on the DS model. Two possible reasons are analyzed. The first one is the threshold effect, that is only fires greater than some given threshold are recoded. The simulation reveals that the fire intervals distribute as exponential law whether a threshold is applied or not. The second one is the external driving. Instead of a constant, the igniting probability f is calculated with the weather parameter, i.e. relative humility, and then it is introduced to the model. The results demonstrate that the frequency-interval distribution of WD model does not exhibits exponential law as DS model, but a power law with periodic fluctuations, of which the period is as large as about 24 hours or one day, coinciding good with actual forest fire data. Furthermore, it is found that the change of weather data also exhibits a power-law relation with periodic fluctuations, implying that the external driving from weather parameters is the essential reason for the power-law distribution of fire intervals.