On the agreement between small-world-like OFC model and real earthquakes from different regions

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Despite all the existing knowledge about the production of seismic waves through slips on faults, much remains to be discovered regarding the dynamics responsible for these slips. A key step in deepening this knowledge is the study, analysis and modeling of the seismic distributions in space and time. The concept of self-organized criticality (SOC), widely used in statistical physics, refers, generally, to the property that a large class of dynamical systems has to organize spontaneously into a dynamic critical state without the need for any fine tuning of some external control parameter. Aiming to contribute to the understanding of earthquake dynamics, in this work we implemented simulations of the model developed by Olami, Feder and Christensen (OFC model), which incorporate characteristics of self-organized criticality and displays a phenomenology similar to the one found in actual earthquakes. We applied the OFC model for two different topologies: regular and small-world, where in the latter the links are randomly rewired with probability p. In both topologies, we have studied the distribution of time intervals between consecutive earthquakes and the border effects present in each one. In addition, we also have characterized the influence that the probability p produces in certain characteristics of the lattice and in the intensity of border effects. Furthermore, in order to contribute the understanding of long-distance relations between seismic activities we have built complex networks of successive epicenters from synthetic catalogs produced with the OFC model, using both regular and small-world topologies. In our results, distributions arise belonging to Tsallis family distributions functions. We also performed the complex network analysis for real earthquakes, taking in account two different ways. The first one, considering only regional earthquakes separately (in regions with high seismicity, as Japan and California, and low seismicity, as Brazil). In the second, considering events for the entire world, with magnitude larger or equal than 4.5, in Richter scale. It is noteworthy that we have found a good agreement between the results obtained for the OFC model with small-world topology and the results for real earthquakes. Our findings reinforce the idea that the Earth is in a critical self-organized state and furthermore point towards temporal and spatial correlations between earthquakes in different places.

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