Earthquake productivity law

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One of the most important properties of seismicity is clustering in space and time, which manifests itself in the form of aftershocks, foreshocks, and swarms of earthquakes. Such interdependent events form a significant part of all seismic events. To explain the observed sequences, a number of mechanisms for the stress transfer and dynamic triggering of earthquakes were investigated by many authors. However, such mechanisms still cannot fully explain the causal relationships between events. In this paper, for each earthquake we introduce the parameter "earthquake productivity," defined as the size of a local cluster of seismic events in a space-time-magnitude domain, triggered by it. The local cluster is associated with only one earthquake-trigger, and each cluster element, in turn, is a trigger for the local cluster of the next level of the hierarchy. A cluster can consist of just one event. We demonstrate that productivity does not depend on the magnitude of an earthquake and, similarly to magnitude, follows the law of exponential distribution. The average size of a local cluster is an estimate of the only parameter of this distribution. We show that this parameter practically does not depend on the level of the hierarchy, but essentially depends on the depth, thus demonstrating the ability to serve as an indicator of the state of stress of the environment. It is also shown that the choice of the proximity function [Baesi, Paschucky, 2004; Zaliapin, Ben-Zion, 2013, Savage, 1972], used to determine which particular earthquake was a trigger for the subsequent seismic events, does not affect the shape of the distribution of earthquake productivity. The work was partially supported by RFBR, grants 17-05-00749 and 19-05-00812.