Earthquake productivity law

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Earthquakes are usually followed by aftershocks. The number of aftershocks - the so-called productivity - depends on the magnitude of the earthquake. In seismic modeling it is usually assumed that the number of aftershocks is approximately the same for earthquakes with the same magnitude. This is one of the key assumptions on which the calculations are based. Although it is

known that in reality this number can vary widely, only recently a pattern of such changes, called the earthquake productivity law, has been established. If we consider only direct aftershocks in a fixed magnitude range relative to the magnitude of the main shocks, then their number for a set of earthquakes in some spatiotemporal volume has an exponential distribution form. This means that fewer aftershocks are more likely. The most likely outcome is the complete absence of aftershocks. This pattern is quite counterintuitive, especially when considering aftershocks over a wide range of magnitudes. Here we managed to confirm the fulfillment of the earthquake productivity law for the wide range of magnitudes. For earthquakes of magnitude 6 and higher in the land part of Japan, it is confirmed that the frequency distribution of the number of their direct aftershocks with a minimum magnitude of 5 units less has an exponential shape. In seismicity modeling the validated earthquake productivity law makes it possible to replace the incorrect assumption of constant earthquake productivity with an exponential distribution. The single parameter of this regularity is easily determined from the actual data. This removes, in particular, a significant limitation for the widely used ETAS model, which consists in the requirement that the average number of immediate aftershocks per trigger event be less than 1, otherwise the sequence of events diverges. The work was supported by the Russian Science Foundation, grant 20-17-00180.