Some new methods and results in examination of distribution of rare strongest events

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In the study of disaster statistics the examination of the distribution tail – the range of rare strongest events - appears to be the mostly difficult and the mostly important problem. We discuss here this problem using two different approaches. In the first one we use the limit distributions of the theory of extreme values for parameterization of behavior of the distribution tail. Our method consists in estimation of the maximum size $M_{max}(T)$ (e.g. magnitude, earthquake energy, PGA value, victims or economic losses from catastrophe, etc.) that will occur in a prescribed future time interval T. In this particular case we combine the historical earthquake catalogs with instrumental ones since historical catalogs cover much longer time periods and thus can essentially improve seismic statistics in the higher magnitude domain. We apply here this technique to two historical Japan catalogs (the Usami earthquake catalog 599–1884, and the Utsu catalog, 1885–1925) and to the instrumental JMA catalog (1926–2014). We have compared the parameters of historical catalogs with ones derived from the instrumental JMA catalog and have found that the Usami catalog is incompatible with the instrumental one, whereas the Utsu catalog is statistically compatible in the higher magnitude domain with the JMA catalog. In all examined cases the effect of the "bending down" of the graph of strong earthquake recurrence was found as the typical of the seismic regime. Another method is connected with the use of the multiplicative cascade model (that in some aspects is an analogue of the ETAS model). It is known that the ordinary Gutenberg–Richter law of earthquake recurrence can be imitated within the scheme of multiplicative cascade in which the seismic regime is treated as a sequence of a large number of episodes of avalanche-like relaxation, randomly occurring on the set of metastable subsystems. This model simulates such well known regularity of the seismic regime as a decrease in b-value in connection with the strong earthquakes occurrence. If the memory of the system is taken into account the cascade model simulates the Omori law of aftershock number decay, the existence of the foreshock activity and the seismic cycle. We use here the cascade model to imitate the effect of "bending down" of the graph of strong earthquake recurrence and the possibility of occurrence of characteristic earthquakes. The results are compared with the seismicity and the physical conditions of occurrence of characteristic earthquakes are suggested. Examples of mutual interpretation of results obtained in the case of the use of theory of extreme values and of the use of the cascade model are presented.