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Nonextensive characteristics of earthquakes magnitude distribution in Javakheti region, Georgia

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For last several years nonextensive statistical mechanics is increasingly used to study wide range of complex phenomena exhibiting the scale free nature in different domains. It is assumed that nonextensivity concepts may provide a suitable framework to shed new light on features of spatiotemporal and energetic behavior of seismic processes which presently are not fully understood. In present research we studied cumulative distribution of earthquakes magnitudes in Caucasus from both common and nonextensive statistical mechanics point of views. Data sets of earthquakes magnitudes from 1960 to 1991 have been compiled from data bases of Seismic Monitoring Center at Ilia State University in Georgia. Javakheti Region in Southern Georgia was selected based on its geological structure and high seismic activity; exact time interval was specified because of increased seismic activity in Caucasus for that period. Together with common seismic characteristics such as a and$b$values of Gutenberg-Richter relationship, we evaluated nonextensive characteristics in the framework of earthquakes fragment-asperity interaction model. Namely nonextensive parameter $q$and energy density value a were calculated. All these characteristics have been assessed for the whole observation period as well as for consecutive 10 year overlapping sliding windows. It was observed that calculated nonextensive characteristics both for whole catalogue and for sliding windows (q=1.6-1.83) are close to the range found earlier for other regions. At the same time we see that both$a$and$q$ values vary in the investigated period, for consecutive sliding windows. These changes are statistically significant and obviously are related to the earthquake generation process of Javakheti region. Indeed, it was observed that nonextensivity parameter increases according to local seismic activity, which may point to the increase of functional relationship between above parameters prior and during earthquake generation. At the same time energy density value a, which is assumed to be related with spatial distribution, decreases after strongest event for the considered time period. These results point to increased long range correlations of seismic process in energetic and spatial domains prior and during strongest regional earthquakes. Results of nonextensive analysis are in good accordance with b value analysis. After strongest event b value increases and a decreases that is consistent with a physical meaning of these parameters.

Results of our research supports assumption that nonextensive statistics can provide a new promising approach to earthquakes distribution features in different domains.