Geophysical Research Abstracts
Vol. 20, EGU2018-8417, 2018
EGU General Assembly 2018

Stochastic modelling of non-stationary earthquake time series with long-term clustering effects

Georgios Michas (1,2) and Filippos Vallianatos (1,2)

(1) UNESCO Chair on Solid Earth Physics and Geohazards Risk Reduction, Technological Educational Institute of Crete, Chania, Greece. (gmichas@hotmail.com), (2) Laboratory of Geophysics and Seismology, Technological Educational Institute of Crete, Chania, Greece.

Earthquake time series are widely used to characterize the main features of regional seismicity and to provide useful insights into the earthquake dynamics. Properties such as fractality/multifractality, intermittency and non-stationary clustering are common in earthquake time series, highlighting the complex nature of the earthquake generation process (e.g., Michas et al., 2015). Here we study the non-stationary earthquake activity in Southern California and Japan and analyse the probability density function (pdf) of the inter-event time series, i.e. the time intervals between the successive earthquakes, for various spatial areas and threshold magnitudes. Our analysis shows that the various pdf present scaling and two power-law regions at both short and long inter-event times, indicating clustering effects at both short and long-time scales, which can be related to aftershock sequences and the background activity, respectively. In addition, we use a stochastic dynamical mechanism with long-term memory effects to model this behaviour. During stationary periods, where the seismic rate is relatively constant, the solution of this mechanism is the gamma distribution, while for non-stationary periods the solution is a generalized gamma distribution, which exhibits asymptotic power-law behaviour (Michas et al., 2013; Vallianatos et al., 2016). Our analysis shows that the generalized gamma distribution can well describe the observed pdf in Southern California and Japan, emphasizing the clustering effects at all time scales in regional non-stationary earthquake time series.

References

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Acknowledgements

G. Michas acknowledges financial support from an AXA Research Fund postdoctoral grant.