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Temporal variations of b-values in Central Ionian Islands

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Our study investigates the temporal patterns of b-values in Central Ionian Islands during the last decade. This data-rich case study includes the January-February 2014 earthquake doublet of Kefalonia Island and the associated earthquakes and the 2015 sequence of Lefkada Island (Karakostas *et al*., 2015; Papadimitriou *et al.*, 2017). For the interpretation of the temporal variations of b-values it is crucial to use high quality data and consistent earthquake catalogs compiled based on a homogeneous monitoring network. For that purpose we use a dataset with events occurred in Central Ionian Islands for the period between 2008 and 2017. The magnitude of completeness is computed through the application of the goodness-of-fit method (Wiemer and Wyss, 2000, Figure 1). For safety we add 0.1 and consequently, the magnitude threshold is set $M_{th} = 2.8$.

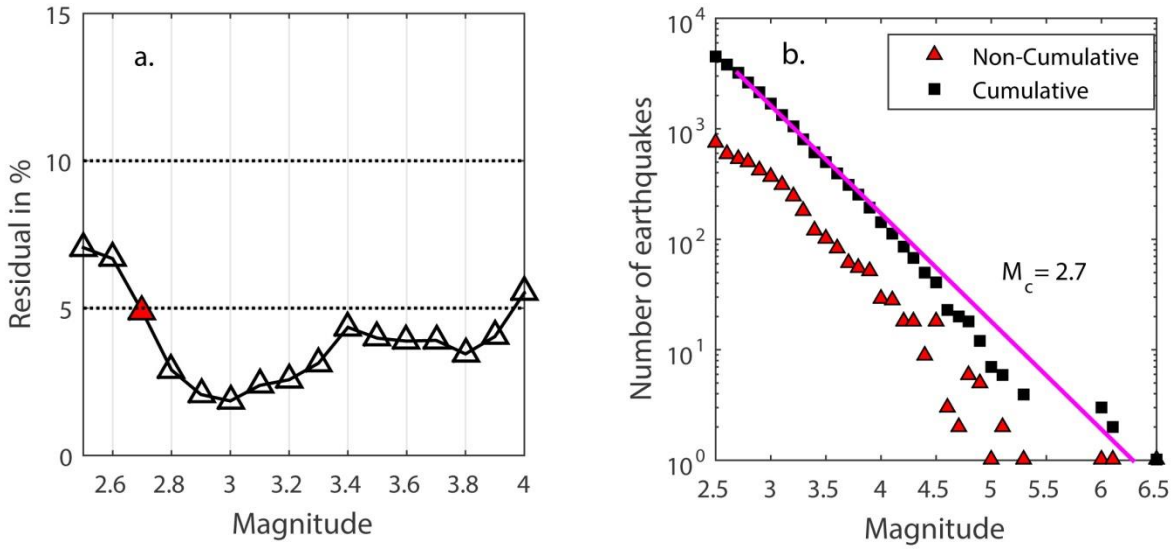

Figure 1a. Residual plot between the observed frequency magnitude distribution (FMD) and the perfect fit of the power law for each magnitude bin. Red triangle shows the completeness magnitude *Mc*. b. Incremental (triangles) and cumulative (squares) FMD, respectively, of the Central Ionian Islands earthquake catalog. The line represents the best fitting model after the application of GFT method.

The temporal evolution of b-values is analyzed by means of two different techniques (Tormann *et al*., 2013). The former is the constant – time – windows technique, where fixed length time windows are used to estimate b-values through time, and the latter is the fixed – number – of events approach. When applying the fixed – number – of – events approach we are based on the average annual number of events occurred in the selected period with $M \geq M_{th}$. In our case, it is found that $\overline{N}_{ann} = 265$ earthquakes. We show that changing the value of the number of events within reasonable limits (-50, 50) does not change the shape of the time-series. For the constant – time – windows technique, a wider variety of time windows is examined since both seismic excitation and relative quiescence are present in the dataset and an average period cannot be applied. The time windows range from a few months to 2 years.

We argue that when significantly varying seismicity rates are observed in a region, like in the case examined, the approach of constant – time – windows is biased. On the one hand, small time windows are able to capture abrupt changes but then, when seismicity is relatively low, many empty bins are created, and on the other, large time windows fill all the bins but are not able to track immediate changes and provide detailed information. The red line in Figure 2, for example, which corresponds to a time window of 2 years, does not seem able to capture b-value variations due to the 2014 Kefalonia doublet and the 2015 Lefkada main shock, which are apparent to the black line.

The overlap between successive b-value estimates is also investigated within different ranges from no overlap to continuously moving the window by one event at a time. The larger is the overlap the smaller is the sensitivity of choosing the starting point of the analysis and the larger are the details depicted in the time-series. Figure 2 shows an example of 80% overlap between successive windows.

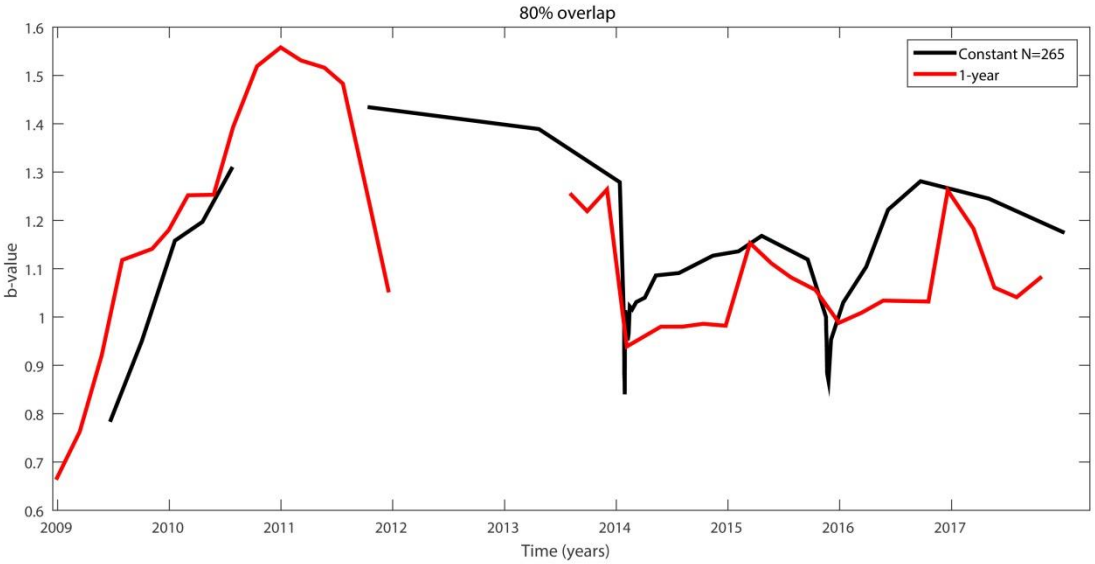

Figure 2. Comparison of b-value time-series for different sampling techniques: constant number, N, of events (black) versus constant time T, windows (red). N is set 265 events, i.e. the annual average number of events and T=1 years. 80 %overlapping is set for both cases.

Summary

In this study different techniques are investigated for a detailed analysis of the temporal evolution of b-values in the Central Ionian Islands area. This is particularly intriguing, since monitoring the evolution of b-values through time rather than a mere comparison of absolute b-values could be translated into changes in stress levels.

Acknowledgements

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