Interactive comment on "Simple statistics for complex Earthquakes' time distribution" by Teimuraz Matcharashvili et al.

Anonymous Referee #2
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GENERAL COMMENTS The authors describes a simple statistical methods to evaluate the time series distribution of earthquakes picked up from the Californian Earthquake Data Center.

SPECIFIC COMMENTS They limit the study since 1975, why? The Catalog reports data since at least 1932. They select the earthquake's magnitudes greater than 2.6, moreover they do not make distinctions between depths of hypocenter.

As it is underlined in the revised version of manuscript, we aimed to analyze temporal features of original earthquakes generation process. For this, we selected the best quality catalogue of southern Californian seismic activity (Fig. 1). Knowing problems, which can be caused by inappropriate "bleaching" of complex data sets [e.g. Abarbanel, 1993], in this work aiming at the analysis of temporal features of the original seismic process, we needed to avoid procedures like cleaning, filtering or declustering. Otherwise it would be impossible to preserve original time structure of earthquakes distribution. This, together with the necessity to have as possible long data sets, forced us to select as possible long period of observation with as possible low representative threshold. Such compromise, when catalogue is long enough and completeness threshold is as low as possible, according to results of time completeness analysis, seemed to be possible from 1975. Indeed, in Fig. 3, we see that since the middle of 70th of the last century Mc clearly decreased, what finally enabled us to work with southern Californian earthquake catalogue with magnitude of completeness M=2.6, according to the Gutenberg–Richter relationship analysis (see Fig. 2). We understand that in such catalogue we deal with both independent, as well as dependent (aftershocks or foreshocks) events, but in the frame of aims, targeted in the present work this is quite acceptable, because we speak about general temporal behavior of seismic process and because, as it is known, physics of generation of dependent and independent events is similar (See e.g. [Davidsen, Goltz, Geophys. Res. Lett.31(2004), pp. L21612.; P. Bak, C. Tang, K. Wiesenfeld, Phys. Rev. A 38(1) (1988), pp.364–374]).

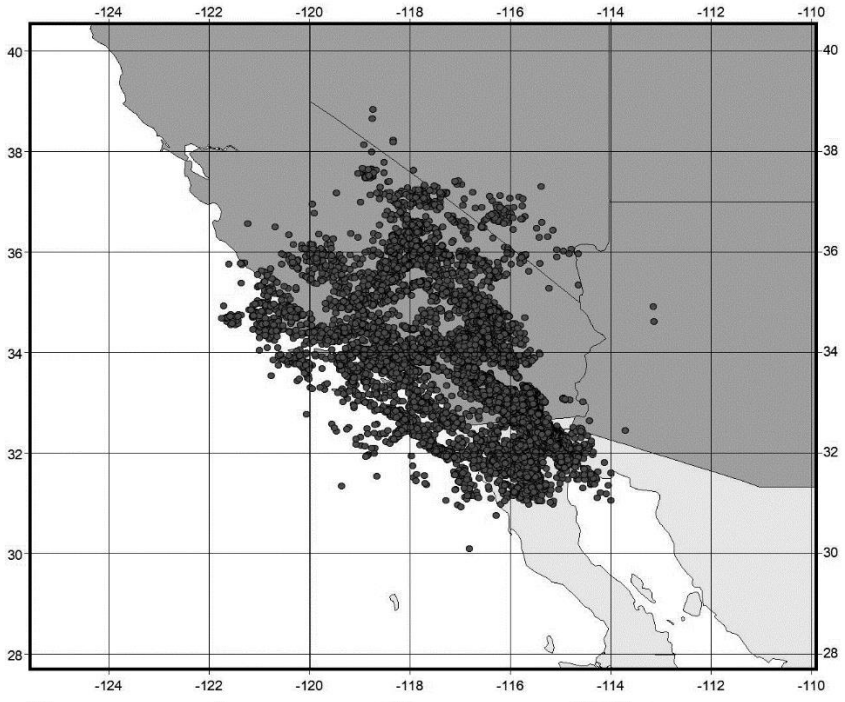
-124
-122
-120
-118
-116
-114
-112
-110
40
38
36
34
32
30
28

Fig. 1.

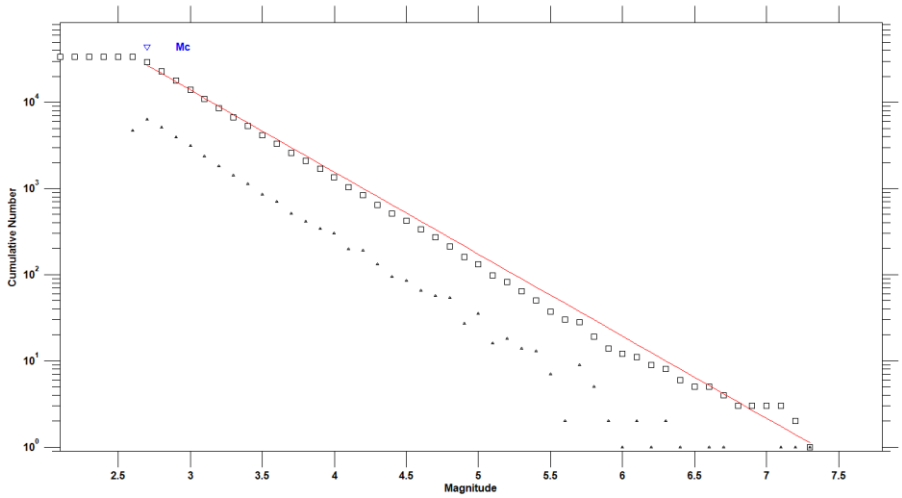
Mc
Cumulative Number
Magnitude
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5

Fig. 2.

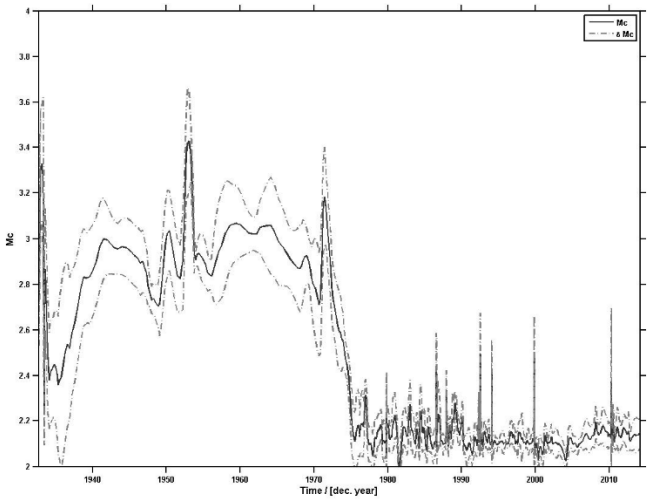

Fig. 3.

We would like further underline that, in any case to assess the possible influence of dependent events on the results of our calculations, we performed analysis at higher representative thresholds M3.6, M4.6 and even for M5.6. According to our analysis dependent events do not essentially influence results of IDT analysis.

Reviewer is correct saying that author of manuscript "do not make distinctions between depths of hypocenter". From above said it should not be surprising that we do not wanted to differentiate entire process by hypocenters depths and thus change the time structure of original earthquake occurrences. As we pointed above, from the same logic we do not make any catalogue cleaning, declustering, etc. Again, this was quite logical for the targeted research purpose, aiming at the analysis of temporal features of the original (natural) seismic process. This goal to be correctly achieved necessitates avoiding artificial distortion of original dynamical features of earthquakes time distribution, what usually is impossible by any cleaning or filtering of catalogue (especially of such high quality as used in our work south Californian earthquake catalogue). We base our analysis on the often practice, when [see e.g. P. Bak, in (How Nature Works: The Science of Self-Organized Criticality,1996); Christensen et al.(in Proc.Natl. Acad. Sci. U.S.A. 99, 2509, 2002); Corral (in Phys.Rev.Letters, 2004); Corral (in Phys. Rev. E 68, 035102(R) 2003); etc.] seismic processes in catalogue is regarded as a whole, irrespective of the details of tectonic features, earthquakes location or their classification as mainshocks or aftershocks. Thus, we logically abandoned also differentiation of earthquakes according to depths of hypocenters.

In fact, answers to the almost all questions of reviewer 2, are already done in one of the famous articles of Alvaro Corral (in Phys. Rev. E 68, 035102(R) 2003) where it is said that view similar to used in our analysis ".. follows one of the key guidelines of complexity philosophy, which is to find descriptions on a general level; the existence of general laws fulfilled by all the earthquakes unveil a degree of unity in an extremely complex phenomenon".

The authors
don’t even identify the spatial region, they simply took the data in the archive taken without criticism. They don’t select the main shock from aftershocks.

Answers to these remarks, see above.

So the statistical
description and the results are affected by these undefined choices.

Here we completely agree with the statement of reviewer 2. Indeed, our results obtained by analyzes accomplished by the carefully tested IDT method, express features of earthquakes’ time distribution in the original catalogue, in which the temporal structure of seismic process (as possible) is not distorted by the some, not always well grounded, procedures. Unfortunately, blind inclinations of some researchers to change reality in accordance with their personal preferences or to make “defined choices”, especially when we deal with complex process, often lead to unscientific and incorrect conclusions. Thus, YES, we agree that results really are affected by the features of natural earthquake's time distribution. Moreover, our results reflect features of this natural (as possible untouched) seismic process. This is why they are new and important, as they show changing in time extent of regularity and periods, when seismic process is most random-like.

The Conclusions are trivial.

We would sincerely appreciate reviewer 2, if he/she could provide in depth explanation why our results can be regarded as trivial. In the report of reviewer 2, we do not see any documentation indicating that our findings are something well known or not deserving any attention. Especially we’d be glad to get references, in which it is shown convincingly that the extent of randomness in earthquake time distribution is changing over time and that there are better methods applicable to short periods, when the seismic process is closer to randomness.

CONCLUDING REMARK The goals of the work are not well motivated; it seems to be a mere statistical exercise.

It is said in manuscript that the motivation for the present work was to assess how the extent of regularity in the earthquakes time distribution changes over the considered period of catalogue time span. This problem, in spite of wide scientific interest [e.g. Davidsen, C. Goltz, 2004; Kawamura. 2007; Kenner, M. Simons, 2005; etc.] still remains unanswered. At the same time, it is clear that without such knowledge the better understanding of seismic processes can not be achieved. Moreover, scientific posing of such general tasks as earthquake prediction or forecast, will not look well-grounded unless basic features of seismic process dynamics in spatial, temporal or energy domains will not be understood.

We think that analysis of simulated data sets, carefully accomplished in our research, should not be regarded just as “statistical exercise”. The matter is that one needs to fulfill analysis by suggested IDT method on simulated complex data sets with (predefined) different extent of randomness in order to apply the method to seismic data sets with unknown complex structure. Only after such comparative analysis (calibration) and appropriate data selection we could undoubtedly prove that IDT approach is able to discern and quantify the changes in the complexity level of the process even in the case when we deal with short data sets from a complex process like seismicity. So, this analysis was a necessary part of research aimed to present and launch the new method of IDT.

Besides, in our opinion results obtained from the careful analysis of different simulated random data sets, given compactly in one article, will be undoubtedly helpful for researchers from different fields for different testing purposes.

So the paper needs a deep afterthought.

We corrected our manuscript significantly. The revised version of manuscript contains a result of additional work and testing of data sets.