Short report on the work carried out in the frame of on research proposal “Scaling features of earthquakes time distribution - field and model data analysis”

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At the start of my 3 month visit at ERI, together with my host Prof. T. Hatano we once again discussed details of joint research. We have critically considered research problems which were preliminary agreed and are listed in project's proposal. These discussions helped us to select the most promising and important, in my opinion, question in the frame of present joint work which at the same time may serve as a basis for future collaboration between M. Nodia Institute of Geophysics, Tbilisi, Georgia and Earthquake Research Institute, Tokyo, Japan.

Exactly, several research ideas have been critically discussed in the light of different literature sources on the scaling features of the seismic process, as well as recently appeared methods of modern data analysis. Additionally, available for us models and seismic data sets have been considered from the point of view of reliability to these research ideas.

After these discussions, it was decided that old problem of scaling features of earthquakes time, space energy distribution can promisingly be viewed from the novel perspective. Namely, we preferred to focus on features of seismic process prior to strongest regional earthquakes considering data sets of time intervals, distances and magnitudes differences of earthquakes in catalogues, comparing to the time, location and magnitude of main shock. Compiled from these scalar data sets multidimensional data sequences may provide interesting possibility to quantify changes occurred in seismic process prior to strongest regional earthquake based on modern interdisciplinary concepts of complex data analysis. Exactly we compile new data set of Euclidean distances between normed values of time intervals, distances and magnitude differences prior to main shock. Obtained in this way data sets enables to test scaling features of the seismic process. Indeed reconstructed data sets (based on available information on earthquakes time, spatial and magnitude characteristics) involve temporal spatial and energetic features of earthquake generation process. After, by calculation of Mahalanobis distance values of these reconstructed data sets, for sliding windows of different length at different magnitude threshold values, it can be possible to speak about the significance of differences between scalling characteristics of seismic process when approaching to strongest regional earthquakes. Furthermore, these data sets can be used for different complexity measure procedures including recurrence quantification analysis, Lempel and Ziv complexity measure, etc.

We started to test our approach on different original and model catalogues. First we use Southern California catalogue from 1960-2015 as well as earthquake catalogue of Japan (earthquakes occurred in 1997/10/01-2010/01/01, whose epicenters are in E140-E150, N35-N42). We decide to start from these catalogues for two main reasons. First because investigation of seismic processes in California and Japan are important from scientific and practical points of views and on the other hand, adjustment of method on these high quality data sets will help to elaborate standard procedures which can later be used also for other, not so good quality, data sets. Thus, necessary for our analysis data sets have been compiled and preliminary testing carried out.

At this stage of research we have preliminary results indicating changes in the level of significance in Mahalanobis distance calculation at different time periods prior to main shocks in California. Exactly we analysed 10 year periods prior M7.1, M7.2 and M7.3 earthquakes. Changes in complexity measure values of compiled data sets show that research will be successful.

In parallel to this we started analysis of earthquakes time occurrence to assess portion of events occurred in time earlier or later comparing to the time structure of occurrence of events if it will be distributed regular and/or random in time.

Together with all these model sequences of time, distance and magnitude data sets have been generated in which original temporal, spatial and energetic structures of seismic process has been destroyed. Such data sets will be used to assess significance of differences which, as we propose, can be found in original data sets at approach to main shock.

At present we continue our analysis and hope that above mentioned approach in future we will use also for laboratory model data sets of stick-slip acoustic emission.

We hope that in near future we will be able to publish preliminary results of our analysis. Also we hope that on the basis of these novel views and results of analysis we will be able to prepare collaborative research proposal for further researches.

Finally I would like to express sincere gratitude to University of Tokyo, ERI and to my host Prof. T. Hatano for invitation and opportunity to carry out joint research.