Geophysical Research Abstracts
Vol. 12, EGU2010-12895, 2010
EGU General Assembly 2010

Intraplate seismicity in Canada: Complex network analysis of spatio-temporal recurrences

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Intraplate seismicity in certain regions of Ontario, Quebec, and Nunavut in Canada is a subject of this abstract. The reasons for the occurrence and periodicity of the intraplate earthquakes are not as well understood as the interplate earthquakes. Here, we undertake a complex network analysis with a view to extract information from the physical structure of the network of recurrent seismic events that occur in space and time that can provide insights concerning the causality of seismic events. To this end, we have identified three areas for our study as defined by the following ranges of latitude/longitude values: area 1: 45^o-48^o/74^o-80^o; area 2: 42^o-45^o/76^o-81^o; area 2: 51^o-55^o/77^o-83^o; area 4: 45^o-57^o/80^o-98^o; and area 3: 56^o-70^o/65^o-95^o. In this work, using a recently proposed definition of "recurrences" based on record breaking processes (Phys. Rev. E 77, 066107, 2008), we have constructed digraphs of the data extracted from the five areas (http://earthquakescanada.nrcan.gc.ca) with attributes drawn from the location of the events, the time of occurrences and the magnitude of the events. For a quantitative insight into the digraphs of the recurring events in space and time, we have examined the probability distributions of space-interval and time-interval recurrences for different magnitudes of earthquakes, the network properties such as the in-degree as well as the out-degree distributions for different magnitudes, the clustering coefficient, and the degree correlations between a given event and its recurrences. Since there is an uncertainty in spatial locations of earthquakes, we have allowed for uncertainty in recurrences as well to generate a new suite of digraphs for error analysis. Furthermore, to test for the presence of non-trivial spatiotemporal correlations and causal connections, we have carried out a series of Monte-Carlo simulations by reshuffling the spatial locations and magnitudes of the earthquakes without altering the time of occurrences. Here, we present the results of our study, compare them with similar ones obtained for a data set in an active, well-studied interplate region such as southern California, and draw certain conclusions about the physical structure of the intraplate seismicity in Canada.