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Some Comments on Waiting Time Distributions and Physics of Earthquake Processes

M. Lindman, K. Jónsdóttir, R. Roberts, B. Lund and R. Bödvarsson

Department of Earth Sciences, Uppsala University, Sweden (mattias.lindman@geo.uu.se / Phone +46 18 471 14 74)

For possible earthquake prediction it is necessary to fully understand the physics of earthquake processes. In this context scaling laws for earthquakes attract considerable interest and a number of studies of their spatial and temporal scaling behaviour have been published. One approach which has recently been used by several authors is to study the distribution of waiting times between successive earthquakes for a given region.

In a region dominated by aftershock activity a typical waiting time distribution is dominated by power law behaviour, but with significant deviation at the longest and the shortest waiting times. The power law regime reflects the Omori law for the decay of the rate of aftershocks while the deviations have been interpreted differently. At short waiting times the deviation is often assumed to reflect "data loss" while at long waiting times the deviation has been considered to be due to a regime of uncorrelated earthquakes. Moreover, the power law behaviour together with the scaling and data collapse of waiting time distributions with different cut-off magnitudes and spatial ranges have been taken to indicate that earthquakes are a self-organized critical (SOC) in a rigorously defined sense.

Thus, some authors claim that earthquakes are SOC and that this implies that large earthquakes are inherently and fundamentally unpredictable in time. It is therefore important to understand whether or not the waiting time distributions necessarily imply an SOC system. We show that the deviation from power law behaviour at long waiting times is simply due to effectively finite Omori series and cannot be taken as evidence for earthquakes being SOC. We consider it likely that the waiting time distributions and earthquake systems in general may be explained without invoking the

SOC concept. We suggest that development of statistical models of earthquake behaviour should generally be used as a step towards a physical model of the system, rather than being an end result in themselves. We illustrate this point by considering fluid flow phenomena and relating these to waiting time data from Iceland.