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Rate-dependent incompleteness of earthquake catalogs

Sebastian Hainzl
GFZ German Research Centre for Geosciences, Potsdam, Germany (hainzl@gfz-potsdam.de)

Important information about the earthquake generation process can be gained from instrumental earthquake catalogs, but this requires complete recordings to avoid biased results. The local completeness magnitude M_c is known to depend on general conditions such as the seismographic network and the environmental noise, which generally limit the possibility to detect small events. The detectability can be additionally reduced by an earthquake-induced increase of the noise-level leading to short-term variations of M_c, which cannot be resolved by traditional methods relying on the analysis of the frequency-magnitude distribution. Based on simple assumptions, I propose a new method to estimate such temporal excursions of M_c solely based on the estimation of the earthquake rate resulting in a high temporal resolution of M_c. The approach is shown to be in agreement with the apparent decrease of the estimated Gutenberg-Richter b-value in high-activity phases of recorded data sets and the observed incompleteness periods after mainshocks. Furthermore, an algorithm to estimate temporal changes of M_c is introduced and applied to empirical aftershock and swarm sequences from California and central Europe, indicating that observed b-value fluctuations are often related to rate-dependent incompleteness of the earthquake catalogs.