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The impact of magnitude errors on basic catalogue properties investigated numerically with synthetic magnitude catalogues

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Earthquake catalogues are the main products of operating seismological networks. Although seismic networks continuously evolve and improve with time, instrumental catalogues containing experimental data are expected to include errors, which inevitably affect the estimation of catalogue properties important for seismicity studies. Here we investigate the error effects in the reported magnitudes of an earthquake catalogue on the estimation of the catalogue magnitude of completeness (Mc) and the Gutenberg-Richter b-value. We use synthetic magnitude catalogues produced under well defined initial assumptions, which are contaminated with Gaussian error, meaning that each event has an equal probability of being either overestimated or underestimated. We define Mc by applying well known techniques and we estimate the corresponding b-values using the maximum likelihood estimator (Aki, 1965). Our study reveals an inherent trend of reporting higher magnitudes for the majority of events close to and above Mc, due to more small events being shifted towards larger magnitudes in comparison to stronger earthquakes which are underestimated and shifted to lower values. This can have a significant impact on the estimation of the b-value, as the larger to smaller events ratio apparently increases. Our results show that there are methods which overestimate Mc when magnitude catalogues include errors, but they provide more reliable estimations for the b-value. Data sets of varying sample size and with different levels of magnitude error are also used, to compare the performance of the tested methodologies in different potential cases.