Earthquake detection capability of the Swiss Seismic Network
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Abstract
A reliable estimate of completeness magnitudes is vital for many seismicity- and hazard-related studies. Here we adopted and further developed the new Probability-based Magnitude of Completeness (PMC) method (Schorlemmer & Woessner 2008). This method determines network detection completeness (M) using only empirical data: earthquake catalog, phase picks, and station information. To evaluate the applicability to low- or moderate-seismicity regions, we performed a case study in Switzerland. The Swiss Seismic Network (SSN) at present is recording seismicity with one of the densest networks of broadband sensors in Europe. Based on data from 1 January 1983 to 31 March 2008, we found strong spatio-temporal variability of network completeness: the highest value of M at 7.9 in Switzerland at present is 2.5 in the Geneva area, close to the national boundary, while M is lower than 1.6 in high-seismicity areas (Graz, Bern, and Aargau). Thus, events of magnitude 2.5 can be detected at the probability level 0.9999 in all of Switzerland. Furthermore, we 1) investigated the temporal evolution of M at the last 20 years seeing the improvement of the SSN; 2) introduced the calculation of uncertainties to the probabilistic method using a bootstrap approach resulting in uncertainties in completeness magnitudes generally less than 0.1 magnitude units. 3) explored the possible use of PMC as a network planning tool with simulating installations of one or more virtual stations to assess the completeness and identify appropriate locations for new station installations. We compared our results with an existing study of the completeness based on detecting the point of deviation from a power-law in the earthquake-size distribution. In general, the new approach provides higher estimates than the traditional one. We associate this observation with the difference in the sensitivity of the two approaches in periods where the event detectability of the seismic networks is low. Our results allow us to move towards a full description of completeness as a function of space and time, which can be used for hazard-model development and forecast-model testing, showing an illustrative example of the applicability of the PMC method to regions with low to moderate seismicity.