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Estimation of the seismic moment release rate of Mars from InSight seismic data

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After the first few months of InSight seismic recordings on Mars, we provide an early estimation of the Martian annual seismic moment release rate.
Although the Viking 2 seismometer did not provide an unambiguous marsquake detection, its seismic record can nevertheless be interpreted such that the seismicity of Mars ranges somewhere between that of the Moon and that of the Earth. In terms of an annual seismic moment release rate, this amounts to an interval of ten orders of magnitude. Evaluation of visible tectonic structures, as well as geodynamic modelling, provide further constraints to narrow down this interval to little more than three orders of magnitude.
Assuming that the moment-frequency distribution of marsquakes follows a distribution similar to that found on Earth and Moon, implying that most of the seismic moment is released in the few largest events, it is possible to estimate the global moment release rate from a small number of events above the completeness threshold of the event catalogue. We developed statistical estimators based on the tapered Gutenberg Richter distribution which allow computing estimates with as few as one such event. Application to several real catalogues for Earth and Moon, and additionally to 560 million synthetic catalogues worth 2.5 billion years of seismicity, shows the feasibility of the approach.
We implemented a Monte Carlo method which evaluates our estimators for marsquakes recorded by InSight, propagates the uncertainty of the individual event's magnitudes and finally determines how likely any given combination of distribution parameters reproduces the moment rate estimation to within the observational uncertainty. The resulting probabilities can then be used as constraint to challenge existing moment rate models.