Aftershock Forecasting based on Coulomb Stress Modelling

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The SAFER (Seismic eArly warning For EuRope) project aims to develop new methodologies and expand the existing ones to respond to the consequences of damaging earthquakes. A particular task of the project is to improve the reliability of aftershock hazard assessments. We are using well-recorded aftershock sequences of large earthquakes to retrospectively test different physical and statistical methods and to assess their predictive power. We present results from a case study of the 1992 Landers aftershocks, focussing on the question: How well can models that combine the rate-and-state theory with the computation of Coulomb stress changes forecast the space and time distribution of aftershocks? We use the slip distribution of the 1992 Landers earthquake (M7.3) inverted by Wald and Heaton (1994) to compute the Coulomb stress changes on 3D optimally-oriented fault planes. The rate-and-state friction model (Dieterich, 1994) is used to calculate the aftershock rates as a function of time and space. Some parameters of the rate-and-state model are fixed to some pre-defined values, while others are continuously updated from the aftershock data. The forecasts of the aftershock activity are evaluated applying likelihood tests for data consistency and comparative performance. Different tests are performed to explore the sensitivity of our estimations to changes of the input parameters. Our results indicate that better forecasts can be obtained when at least some of the rate-and-state parameters are inverted directly from the data. The forecasts show stability and a good agreement with the total number of data after the first several hours from the main shock, however, significant deficiencies in forecasting the spatial distribution are found.