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Aftershock modeling based on uncertain Coulomb stress calculations and rate-state frictional response

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Static stress changes induced by a mainshock are often demonstrated to be correlated with the aftershock activity. However, the correlation is usually not very high and, in particular, aftershocks are observed even in stress shadows where quiescence is expected. Small scale stress heterogeneity has been recently claimed to explain this discrepancy. For the case of the aftershock activity following the 1992 M7.3 Landers (California) earthquake, we demonstrate that the consideration of realistic uncertainties strongly improves the correlation. For this purpose, we firstly analyze the variability of stress changes resulting from the different published slip distributions. We find that the standard deviation of the uncertainty is in most places in the same order as the absolute stress change and that the ratio between both, the coefficient of variation $CV = std/mean$, is approximately constant. This uncertainty has a strong impact on the forecasted aftershock activity if a rate-and-state frictional response of the fault system is taken into account. We use the first day aftershocks to invert for the friction parameters and the coefficient of variation by means of the maximum likelihood method. We show that the inversion leads only to stable and reasonable results which reproduce the spatiotemporal aftershock sequence well, if the uncertainties are properly taken into account. Our estimation yield among others a friction parameter $A\sigma_n \approx$0.015 MPa and a coefficient of variation of 0.95.