EGU2020-20235
https://doi.org/10.5194/egusphere-egu2020-20235
EGU General Assembly 2020

The role of afterslip in driving aftershock sequences

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Aftershock sequences following large tectonic earthquakes exhibit considerable spatio-temporal complexity and suggest causative mechanisms beyond co-seismic, elasto-static Coulomb stress changes in the crust. Candidate mechanisms include dynamic triggering and postseismic processes such as viscoelastic relaxation, poroelastic rebound and aseismic afterslip, which has garnered particular interest recently. Aseismic afterslip – whereby localized frictional sliding within velocity-strengthening rheologies acts to redistribute lithospheric stresses in the postseismic phase – has been suggested by numerous studies to exert dominant control on aftershock sequence evolution, including productivity, spatial distribution and temporal decay.

As evidence is based overwhelmingly on individual case study analysis, we wish to systematically compare key metrics of aseismic afterslip and corresponding aftershock sequences to investigate this relationship. We specifically look for any empirical relationship between the seismic-equivalent moment of aseismic afterslip episodes and the corresponding aftershock sequence productivity. We first compile published afterslip models into a database containing moment estimates over varying time periods, as well as spatial distributions, temporal decays and modelling methodology as a supplementary resource. We then identify the corresponding aftershock sequence from the globally comparable USGS PDE catalog. As expected, coseismic moment exerts an obvious control on both afterslip moment and aftershock productivity – an effect we control for by normalising by mainshock moment and expected productivity (the Utsu-Seki law) respectively. Preliminary results suggest broad variability of both afterslip moment and aftershock productivity with no obvious control of afterslip on aftershocks beyond the scaling with mainshock size, including when separated by mainshock mechanism or region. As this study is insensitive to spatial and temporal distributions, we cannot rule out the potential influence afterslip exerts in these but find no evidence that afterslip drives overall productivity of aftershock sequences.