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Simultaneous dependence of the earthquake-size distribution on faulting style and depth

Paolo Gasperini (1), Antonio Petruccelli (1), Thessa Tormann (2), Danijel Schorlemmer (3), Antonio Pio Rinaldi (2), and Stefan Wiemer (2)

(1) Università di Bologna, Dipartimento di Fisica e Astronomia, Bologna, Italy (paolo.gasperini@unibo.it), (2) Swiss Seismological Service (SED) ETH Zürich, (3) Helmholtz Centre Potsdam (GFZ) Potsdam

Log-linear formulation of number of earthquakes decay with magnitude – commonly expressed by b-value - quantifies the relative proportion between most and less hazardous events. Although considered as a “stand-alone” parameter, differences in b are physically related to different states of stress in the crust in a negative linear way. The stress increases with depth linearly in the brittle upper crust: b decreases monotonically with depth until the brittle-ductile transition surface. On the other side, theory of faulting implies that different stress levels accompany different tectonic regimes around the source volume, higher stress for compressive environments and lower stress extensional environments. Thereby, variations of b with faulting style are expected both on local and global scale, and in particular functionally related to the rake angle of focal mechanisms.
We analyze a local high-quality, focal mechanisms dataset for Southern California to statistically model and test different dependences of b-values and then gather them in multivariable dependence models. We therefore develop a brand new, numerical Maximum Likelihood Method approach for the estimation of the optimal parameters maximizing the loglikelihood function: the models that best explain the physical reality are the right compromise between the contemporary dependence of b on tectonic styles and depth and a proper complexity level.