Geophysical Research Abstracts
Vol. 18, EGU2016-8813, 2016
EGU General Assembly 2016

Relation between aftershock parameters and geodetic slip models: Case study of the 2010 Mw8.8 Maule (Chile) and the 2011 Mw9.0 Tohoku-oki (Japan) earthquakes

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The distribution of local stresses, which represents as well crustal heterogeneity, is the main factor for aftershock triggering. Though neither local stresses nor crustal heterogeneity are known in detail, some information of their distribution is implicitly represented by slip and coupling values on the mainshock fault interface. Taking these two concepts as the main assumptions, we perform a comprehensive analysis of the relation between aftershock characteristics and geodetic measurements on the mainshock fault interface. As a case study we select two megathrust events, the 2010 Mw8.8 Maule (Chile) and the 2011 Mw9.0 Tohoku-oki (Japan), due to the availability of rich aftershock data as well as of geodetic inversion models. To investigate the dependency between these data sets we firstly estimated the aftershock parameter distribution, using a modified ETAS model, which allows to take into account the mainshock rupture extension. Secondly we calculate the correlation between aftershock parameters and coseismic/postseismic slip and interseismic coupling.

We find: (1) aftershocks tend to occur in the areas of high coseismic slip gradient, afterslip and interseismic coupling; (2) aftershock seismic moment is released preferentially in regions of large coseismic slip, coseismic slip gradient and interseismically locked areas; (3) anomalous aftershock parameters occur in the areas of reactivated fault systems.

Moreover, we show that modified ETAS model outperforms the classical one in the cases when the mainshock rupture extension cannot be neglected and represented as a point source. One of the main restriction in the presented analysis is related to the large uncertainties of the inversion models, which limit the significance of our results.