Nonlin. Processes Geophys. Discuss.,
https://doi.org/10.5194/npg-2017-38-SC1, 2017

Nonlinear Processes in Geophysics
Discussions
Open Access

NPGD

Interactive comment

Interactive comment on "Utsu aftershock productivity law explained from geometric operations on the permanent static stress field of mainshocks" *by* Arnaud Mignan

N. Wetzler

nadavw@gsi.gov.il

Received and published: 23 August 2017

The manuscript examines the empirical relationship of the power law aftershock productivity law. The author introduces (not only in this study) the Solid Seismicity Postulate (SSP) to predict the first order mainshock's geometrical static stress perturbation on the crustal ambient stress. The model defines two basic ruptures with respect to the free surface predicting a magnitude dependent deficiency when the rupture hits the surface. Using this physical model he explains the empirical observation. The manuscript is written well and figures are useful. I have two general comments: 1) The role of dynamic triggering. In general aftershock productivity is a product of the

Printer-friendly version

Discussion paper

static and dynamic perturbation superimposed on the regional seismic susceptibility, or faults state [Dieterich, 1994]. Many examples for both dynamic triggering and Coulomb stress explain aftershocks occurrence. Due to the rapid decay of the static stress field, cases of “pure” dynamic triggering are common beyond several fault dimensions rom the mainshock [e.g. Fan and Shearer, 2016]. In the periphery of the fault, the Coulomb stress field and dynamic stress field overlap with a similar fashion, and it is unclear how they interact. My main concern is that the author does not discuss the contribution of dynamic triggering to the aftershock productivity. Does the fact that the predicted “kink” in the aftershock productivity from the geometrical interaction with the surface is due to enhancement of the dynamic triggering? 2) The geometry of the SSP. The first order shape of the SSP is not obvious to me. The geometry of the induced area is predicting a volumetric increase in static stress changes along the rupture area (red in Figure. 3). The rupture of faulted area is the expression of the coseismic slip responding to the elastic rebound. This predicts different degrees of relaxation with respect to the mainshock magnitude and the occurrence of the event in the seismic cycle. In the case of “complete” stress drop the rupture area is predicted to present spatial deficiency in productivity and some variations in the field with respect to the fault complexity. Several papers demonstrate the deficiency in aftershocks at the asperity with the majority of the seismicity focused on the periphery of the fault [Hasegawa et al., 2012; van der Elst and Shaw, 2015; Ross et al., 2017] represented by the orange volume in Figure. 3. My concern is that this model (SSP) is too simplified and does not incorporate basic modern observations.

3) Further clarification regarding the time and spatial windows used for aftershock counting for the case of Southern California is needed

Dieterich, J. H. (1994), A constitutive law for rate of earthquake production and its application to earthquake clustering, J. Geophys. Res., 99(B2), 2601–2618, doi:10.1029/93JB02581. van der Elst, N. J., and B. E. Shaw (2015), Larger aftershocks happen farther away: Nonseparability of magnitude and spatial distributions of aftershocks, Geophys. Res. Lett., 42(14), 5771–5778, doi:10.1002/2015GL064734. Fan, W., and P. M. Shearer (2016), Local near instantaneously dynamically triggered aftershocks of large earthquakes, Science (80-.)., 353(6304), 1133–1136, doi:10.1126/science.aag0013. Hasegawa, A., K. Yoshida, Y. Asano, T. Okada, T. Iinuma, and Y. Ito (2012), Change in stress field after the 2011 great Tohoku-Oki earthquake, Earth Planet. Sci. Lett., 355–356, 231–243, doi:10.1016/j.epsl.2012.08.042. Ross, Z. E., H. Kanamori, and E. Hauksson (2017), Anomalously large complete stress drop during the 2016 M w 5.2 Borrego Springs earthquake inferred by waveform modeling and near-source aftershock deficit, Geophys. Res. Lett., 1–8, doi:10.1002/2017GL073338.

Interactive comment on Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2017-38, 2017.

Printer-friendly version

Discussion paper