Slow decay of postseismic deformation compared with aftershocks following the 2011 Tohoku-oki Earthquake

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In the literature, decays of postseismic deformation rates of large earthquakes were almost comparable to aftershock decays for subduction earthquakes (e.g. Hsu et al. (2006), Lange et al. (2014)). They are characterized by the modified Omori law with p~1, which means "afterslip-triggerred aftershocks". In this study, we focus on the 2011 Tohoku-oki megathrust earthquake using GNSS and seismicity data. On the basis of high-rate analysis of RINEX data and the F3 solution provided by the Geographical Survey Institute (GSI), we clarify the characteristics of postseismic deformation and aftershocks up to five orders of magnitude of time scale. We find that the p value for the postseismic deformation (p_m) is ~0.7, by contrast, that for the aftershocks (p_n) is ~1. Because a rate-and-state-friction model (Helmstetter and Shaw (2009)) predicted $p_m >= p_n$, another or an additional physical mechanism is necessary to explain the data of $p_m < p_n$. One important mechanism is viscoelastic relaxation of asthenosphere, thus we try fitting the postseismic deformation data by combination of afterslip and viscoelastic relaxation (a model of Suito (2017)). The fitting is not poor but fails to reproduce the Omori-like decay. More complex combination models may improve the fitting, but would not make simple Omori-like power-law decays. We need more sophisticated physical model to represent the decay characteristics of postseismic deformation.

Keywords: aftershocks, postseismic deformation, afterslip, viscoelastic relaxation, the 2011 Tohoku Earthquake