Optimized physics-based earthquake forecasts for inland Japan

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We focus on the stress recovery processes after the M=9.0 Tohoku mega-earthquake and how the above influences the earthquake probabilities in active faults of inland Japan. Recent studies present evidence about rapid stress recovery near the trench but as anticipated by rate-and-state friction law, returning to pre-Tohoku “normal” seismicity levels for the active faults in inland Japan is a slower process. We perform a retrospective forecast spanning 10 years (2004-2014) in the Niigata prefecture (mid-west Japan) using physics-based modeling, combining rate-and-state law and Coulomb stress changes, to study earthquake-triggering mechanisms. The key element of our innovation lies in the development of 429 forecast models, as a result of a stochastic optimization within short-time frames (10 days), in order to access the variability of fault constitutive parameters. The aforementioned optimized forecast then competes with a benchmark statistical/empirical Epidemic-Type Aftershock Sequence (ETAS) model already submitted in CSEP-Japan. The testing period starts with the *M*=6.8 2004 Chuetsu mainshock and ends on December 2014, approximately 9 months after the *M*=6.7 post-Tohoku mid-Niigata on April 12th, 2011. Our physics-based optimization goes hand in hand with uncertainty consideration related with the estimation of static stress changes (geometry of active faults, receiver depth, effective friction coefficient) following the *M*=6.8 Chuetsu mainshock and important triggered events at the near source are, the 2007 *M*=6.7 Chuetsu-Oki and the *M*=6.2 post-Tohoku event. The forecasts are evaluated for their predictability, spatial consistency and relative information gain through log-statistics by considering the statistical model as reference. We find that: (1) best-fit solutions correspond to stressing rates between 0.01 and 0.8 bar/yr immediately after the aforementioned mainshocks and (2) Asigma values vary between 0.1 and 2.0, for the few first days following the post-Tohoku and Chuetsu events.

Keywords: physics-based forecasting, stress changes, post-Tohoku recovery

