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A posteriori filtration of the slip-rate time histories

Miriam Kristekova (1), Martin Galis (2,1), Peter Moczo (2), and Jozef Kristek (2)

(1) Geophysical Institute, Slovak Academy of Sciences, Department of seismology, Bratislava, Slovakia (kristekova@savba.sk), (2) Faculty of Mathematics, Physics and Informatics, Comenius University, Department of Astronomy, Physics of the Earth & Meteorology, Bratislava, Slovakia

The traction-at-split-node (TSN) method seems to be the best way for representing the fault discontinuity in the finite-difference and finite-element methods. In most practical applications, however, the spatial grid is not fine enough to properly discretize possibly broad-spectrum slip-rate and stress variations generated by each slipping point as well as the spatial breakdown zone. Consequently, the simulated slip-rate time histories often are not free from spurious high-frequency oscillations. Some numerical modelers apply the artificial damping to reduce the oscillations. An alternative is the application of adaptive smoothing algorithm (ASA, Galis et al. 2010).

Some modelers, however, rely on the a posteriori filtration. Is this approach reasonable? There are two problems. 1. If the oscillations do not affect (change) development and propagation of the rupture (if no on-line smoothing algorithm is applied), it is possible to apply a posteriori low-pass filtration to reduce the oscillations. The problem is that a priori we do not know whether the oscillations change the development of the rupture or not. 2. If possible, the question is how to filter.

We present several methods for a posteriori filtering slip-rate time histories. First we show problems of the commonly used low-pass filtering based on the Fourier transform. Unless filter parameters are carefully adjusted to the character of oscillations, the filtration leads to considerable distortion of the slip rate. We also demonstrate the applications of two recent de-noising methods - discrete wavelet transform and empirical mode decomposition.

We show advantages and disadvantages of applications of the three methods. Moreover, we compare them numerically with ASA. We clearly demonstrate that none of the a posteriori filtration methods can compete with ASA in terms of accuracy and efficiency.