



## Near-field ground motion and dynamic rupture process

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In order to realise the comprehensible simulations of dynamic rupture process and wave propagation, it is important to take into account of fault geometry, stress field and frictional property. Although it is always a difficult task to guess all the factors before an earthquake, there have been a lot of efforts to determine the model parameters for the past earthquakes. According to the data assimilation (parameter studies or inversions) of dynamic rupture process, the fracture energy released during earthquakes is scale dependent from a magnitude 6 to more than 8 (Aochi & Twardzik, 2020; Aochi & Ruiz, 2021). This is consistent with the scaling over a larger range inferred from the seismological and mechanical insights. However, an earthquake is a process to release a part of the loaded stress, since no reversing fault slip is observed and friction may not decrease to zero. It always remains difficult to determine the absolute stress field where the earthquake occurs.

In our first experiences, Aochi & Madariaga (2003) assumed rather a strong fault strength for the 1999 Izmit earthquake, by giving static and dynamic frictional coefficients of  $\mu_s = 0.6$  and  $\mu_d = 0.48$  respectively, namely a possible strength drop is 20 % of the initial strength. The simulations were successful to explain the global feature of this earthquake, including the super-shear rupture propagation. However, the given condition tended to overestimate the fault slip in general while the eastern segment was difficult to rupture. The absolute stress level was high such as about 100 MPa of fault strength at 10 km depth. This led to a large stress drop on a ruptured fault but limited the fault geometry close to the optimal fault direction with respect to the principal stress axes. In the following studies, we decided to assume a moderate fault strength for the scenario earthquakes in the Marmara Sea (Aochi & Ulrich, 2015) with  $\mu_s = 0.3$  and  $\mu_d = 0.24$ . In terms of the simulated ground motions surrounding the fault comparing to the empirical relations, this condition is quite satisfactory.

The 6<sup>th</sup> February 2023 Sofalaca Sehitakamil Gaziantep earthquake (Mw7.7 after KOERI, <http://www.koeri.boun.edu.fr>) recorded again the near-field ground motions along a long fault line (more than 10 stations comparing to four during the 1999 Izmit earthquake). We apply the same procedure and the same configuration of the simulations as the previous ones. In the available ground motion records, one can clearly identify the first rupture around the epicenter (37.1757°N, 37.085°E after KOERI) to the north between the three stations (4615 and NAR from AFAD (<https://tadas.afad.gov.tr/>) and KHMN from KOERI). We are focusing the main rupture, by at least several seconds later, propagating to the south clearly identified at stations at least from 4616 to 3137 and further. A BIEM-FDM simulation allows to calculate the near-field ground motion associated to the dynamic rupture process. A preliminary simulation could reproduce the similar velocity waveforms near the fault, indicating that some observed seismograms reflect directly the source process nearby. In order that the rupture propagates from north to south along different fault azimuth, it is necessary to consider that the principal stress axes rotate in the area.

Aochi & Twardzik (2020) Imaging of seismogenic asperities of the 2016 ML6.0 Amatrice, Central Italy, earthquake through dynamic rupture simulations, *Pageoph*, 170, 1931-1946, <https://doi.org/10.1007/s00024-019-02199-z>. Aochi & Ruiz (2021). Early stage and main ruptures of the 2015 Mw8.3 Illapel, Chile, megathrust earthquake : Kinematic elliptical inversions and dynamic rupture simulations, *J. Geophys. Res.*, 126, e2020JB021207, <https://doi.org/10.1029/2020JB021207>. Aochi and Madariaga (2003). The 1999 Izmit, Turkey, earthquake: Non-planar fault structure, dynamic rupture process and strong ground motion, *Bull. Seism. Soc. Am.*, 93, 1249-1266, <https://doi.org/10.1785/0120020167>. Aochi & Ulrich (2015). A probable earthquake scenario near Istanbul determined from dynamic simulations, *Bull. Seism. Soc. Am.*, 105(3), 1468-1475, <https://doi.org/10.1785/0120140283>.