Simulation of the 2007 Mw6.6 Niigata-Chuetsu-Oki earthquake: Dynamic rupture process, wave propagation and near-field strong ground motion

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The 2007 Mw6.6 Nigiata-ken Chuetsu-Oki earthquake implies a complex fault mechanism other than a simple reverse faulting on a single segment, namely a north-western dipping segment in the north and a south-eastern dipping one in the south, as debated in Kato et al. (EPS, 2008), Nishimura et al., (EPS, 2008), Aoi et al. (EPS, 2008) and Horikawa (technical note of AFRC, AIST, 2008). Such complex fault geometry is not taken into account for any usual seismic hazard evaluation studies. Our first question is how it is mechanically possible for the rupture to transfer between the conjugate faults during this event. We simulate the dynamic rupture process along a complex fault system using a 3D boundary integral equation method. We investigate various parameters in stress and friction and conclude that the possibility of the rupture transfer is very limited. However such complex fault geometry (if known) and possible rupture scenario should be considered for the seismic hazard study in the near-field.

We then compute the wave propagation using a finite difference method in the 3D geological model. After the seismic inversion results (e.g. Aoi et al., 2008; Cirella et al., 2008), the behaviour of the southernmost asperity seems strange. In fact, one of the raised problems is the strong ground motion recorded at the Kashiwazaki-Kariwa nuclear power plant (TEPCO) almost above the implied fault planes, where the contribution of the asperity near-by is strongly inferred. Otherwise most of the waves does not affect a lot along the coastline, as the main fault is considered to be dipping in the south-east, namely beneath the inland.

It remains a strong non-linear behaviour observed in the Kashiwazaki city (NIG018 by K-net, NIED), several kilometres apart from the nuclear plant. Unfortunately there is no acceleration data on a rock site or at depth for its reference. Using the acceleration recorded at the nuclear plant (supposed to be enough rocky site), the characteristics of the non-linear waveforms at NIG018 can be reproduced qualitatively but not enough for the quantitative comparison. This is mainly because the concerned asperity is too close so that it plays a significant role in the incident waves. The aim of the DEBATE project group is to understand and develop the methodology to provide a reliable input ground motion for such engineering non-linear site effect study.