Rapport d'activité

Etude de la génération de séismes et la propagation des ondes sismique
- Study on the earthquake generation and seismic wave propagation processes -

1. General Information

Projet : A0130406700
Responsable : AOCHI Hideo

Allocation
TGCC BULL Joliot Curie/Irene Rome : 330 000 heurs scalaires
IDRIS Jean Zay CSL : 200 000 heures scalaires.

Consommation
TGCC BULL Joliot Curie/Irene Rome : 279 116 heures scalaires (23/08/2023), soit 84 % des heures accordées.
IDRIS Jean Zay CSL : 105 067 heures scalaires (23/08/2023), soit 52 %. (Le compte a été ouvert en janvier 2023).

En total, 384 183 heures / 530 000 = 72 %.

2. Scientific Results (below is written in English)

The previous works have been achieved in **Aochi & Tsuda (GJI, 2023)** focusing on the reverse faulting mechanism such as the 2019 Le Teil, France, earthquake. We had been resting and preparing the model setting and data for the dynamic rupt ure inversion of the 2019 Ridgecrest, California, earthquakes in the framework of the ANR project E-CITY. It was always necessary to check the model-data combination for a small earthquake before a large earthquake of interest. **Figure 1** demonstrates one of our tests of a foreshock (Mw4.0), very close to the hypocenter of the first mainshock. It is very important to know that the closest two stations CCC and LRL are well reproduced regardless of the different models. So, these stations might capture the source property very well. On the other hand, none of the model fits well the observation at station CCC. The arrival of the waves is shifted and later phases might be related to the soft layer, which is taken into account in no model. This test infers that the utilization of CCC may introduce a bias in the inversion process. **Figure 2** demonstrates the preliminary inversion process (final solution is not yet obtained). We were seeking a seismogenic asperity (its location, dimension, and dynamic parameters such as stress drop). The interest of this inversion is if we can find a reliable finite, dynamic source model compatible to the near field data in a complex, conjugate fault system.

However, the 6th February 2023 Turkish earthquakes made us to change the research plan according to the scientific and societal importance. We have been involved in discussion with different researchers (ENS Paris, Stanford Univ., UNAM, Kyoto Univ.) concerning about the dynamic rupture process and near field ground motions. This is the main purpose of our GENCI project as well as the concerned ANR project. **Figures 3 and 4** show our first result focusing on the mechanism of the first event at 01:17 (Mw7.7) (**Aochi, 5SEV, 2023**). We constructed the non-planar fault model (vertical fault) after the InSAR image analysis from ENS group. We then apply the tri-axial stress field in the framework of Mohr-Coulomb diagram. The slip-weakening relation is assumed as a governing equation of fault dynamics. We first execute the parametric studies for each part of the fault system (**Figure 3**), implying that the favorable stress condition is limited. **Figure 4** demonstrates a successful rupture propagation and ground motions towards the SSW over a distance of 150 km. The model is still under calibration and we are discussing

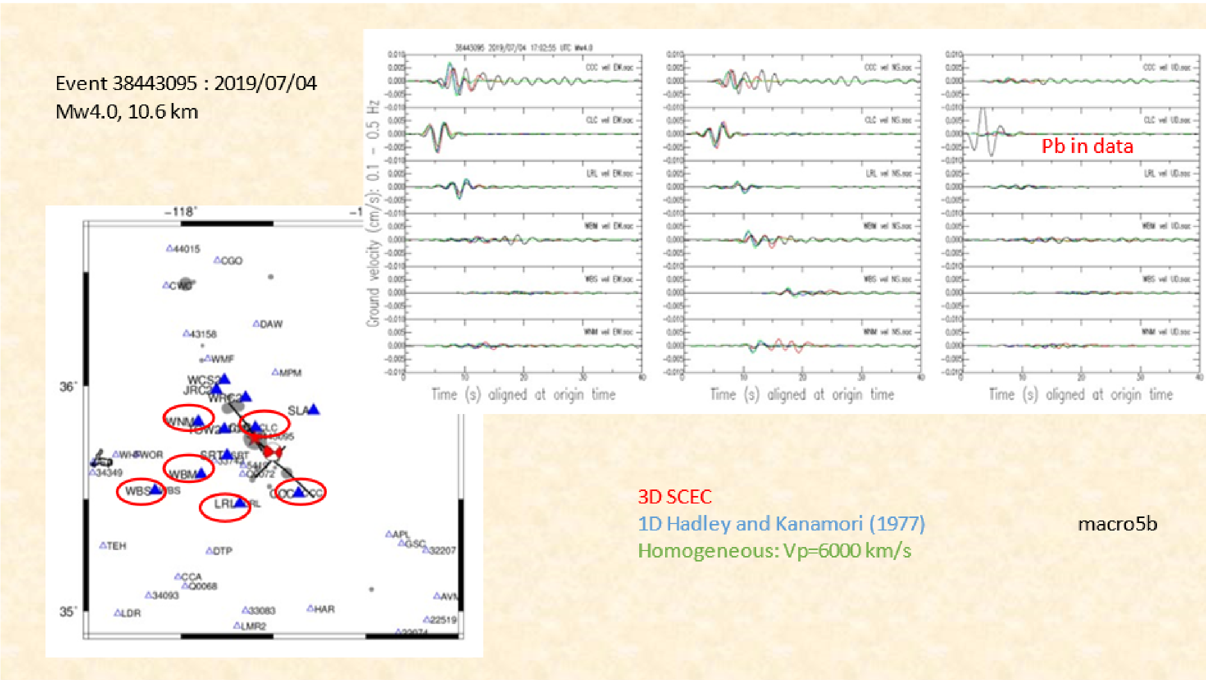

Figure 1: A numerical test of model and station reliability for the 2019 Ridgecrest earthquake. A foreshock of Mw4.0 (focal mechanism) is simulated as a point source in FDM. We compare the three structure models (3D structure from Sothern California Earthquake Center), 1D model by Hadley and Kanamori (1977) and a homogeneous model. The used stations in the near field are highlighted by red circles. The fault models corresponding to the two large earthquakes are shown as bold black lines. The seismograms are compared in velocity with a bandpass filter between 0.1 and 0.5 Hz (unpublished work).

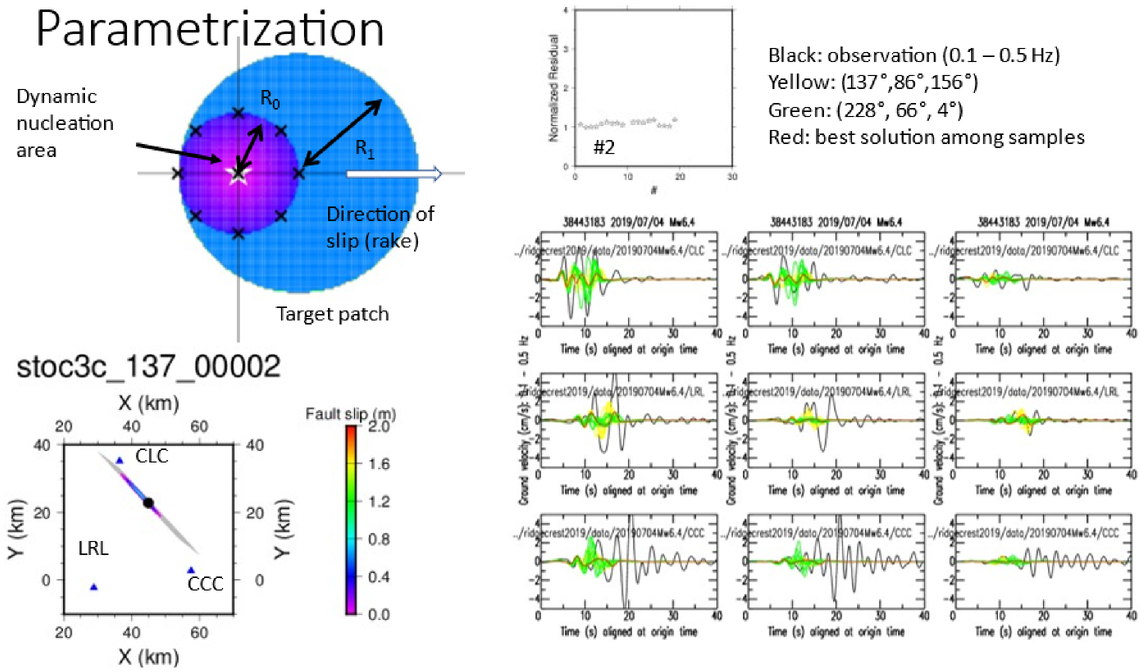

Figure 2: A preliminary dynamic rupture inversion for the Mw6.4 event during the Ridgecrest sequences. The final solution is not yet obtained. We seek the seismogenic asperity around the hypocenter, by the near-field ground motion data. (unpublished work)

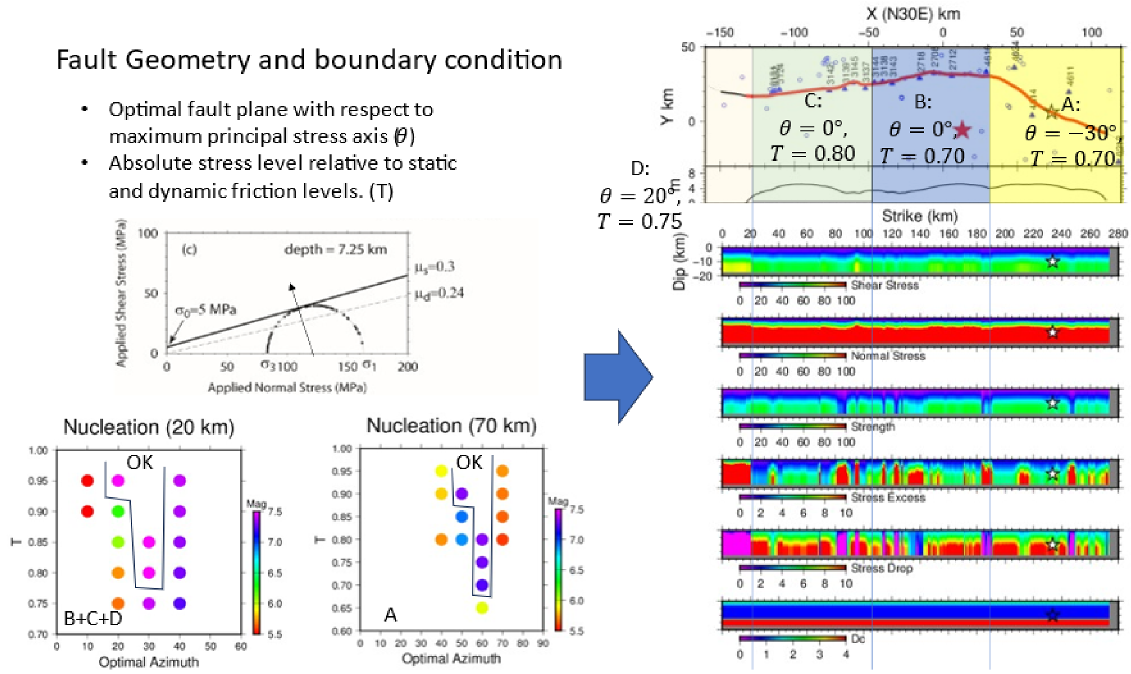

Figure 3: Preparation for dynamic rupture simulation for the first mainshock of the 2023 Turkish earthquake. We consider Mohr-coulomb diagram (top-left corner). We carry out parametric study for rupture progress for two parts (B+C+D and A) from two model parameters (left bottom corner). Fault geometry model and the generated initial condition in the right panel. (Aochi,5SEV, 2023)

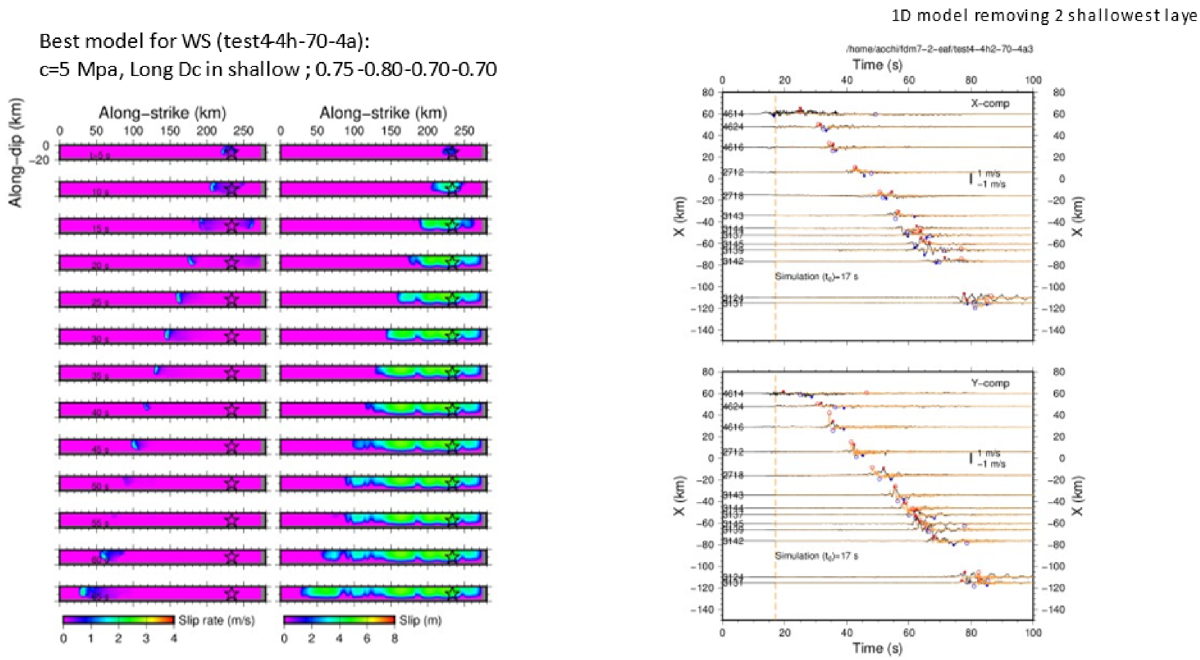

Figure4 : A successful dynamic rupture simulation (left) by BIEM and the resultant ground motions calcualted by FDM and compared with the data. (Aochi, 5GSEV, 2023)

3. Publications submitted or in preparation

Aochi et al. Non-planar fault structure, dynamic rupture process and strong ground motion. (in preparation), 2023.

Aochi, H. and K. Tsuda, Dynamic ruptur simulations based on depth-dependent stress accumulation, Geophys. J. Int. , 233, 182-194, 2023. https://doi.org/10.1093/gji/ggac453

4. Conferences and posters

Aochi, H., Near-field ground motion and dynamic rupture process, V Colloquim on Geophysical Signatures of Earthquakes and Volcanoes (GSEV) and Workshop "Earthquakes: from observations to dynamic rupture simulations", onsite, Santiago, Chile, 22-24 May 2023.

Aochi, H., K. Tsuda, & S. Yoshida, Near-Field Ground Motion Simulation based on Depth-Dependent Stress Accumulation Model I, Interpretation of the 2019 Mw4.9 Le Teil earthquake, Seismological Society of Japan Fall Meeting, Sapporo, Japan, 24-26 October 2022a.

Aochi, H., M. Yamada, & T.-C. Ho, Ground oscillations generated by the passage of Tsunamis : Observations and numerical simulations, Seismological Society of Japan Fall Meeting, Sapporo, Japan, 24-26 October 2022b.