Rupture Models and Implication of Rupture Dynamics in Simulated Ground Motion for the M7, 2016 Kumamoto, Japan Earthquake

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Content

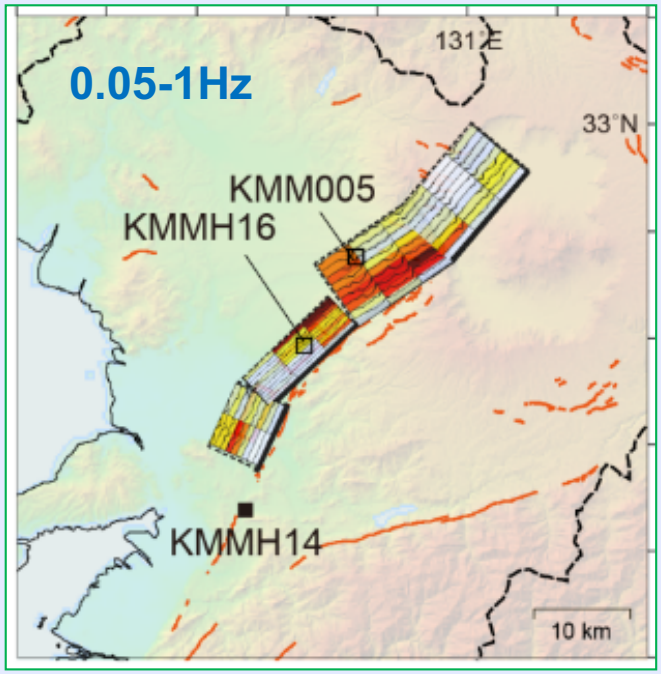
1. Spontaneous rupture modeling of strike slip faulting with shallow weak zone to explain spatial separation between large slip and large slip rate areas observed during M7 Kumamoto Japan earthquake.

2. Asperity-based kinematic rupture models for the Kumamoto earthquake based on Irikura Recipe, modified for inclusion of shallow weak zone effects.

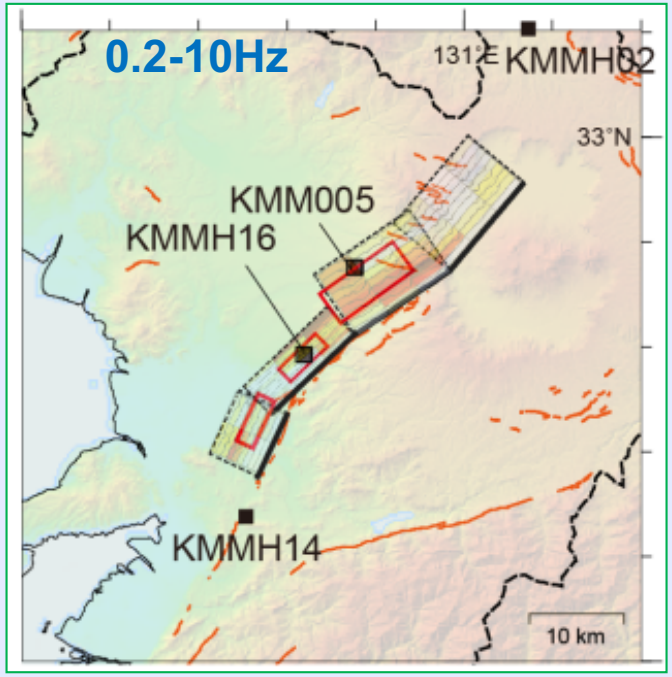
3. Performance of proposed kinematic rupture models in BB simulations of near-fault ground motion for the Kumamoto earthquake

Rupture Models for the M7 Kumamoto, Japan Earthquake

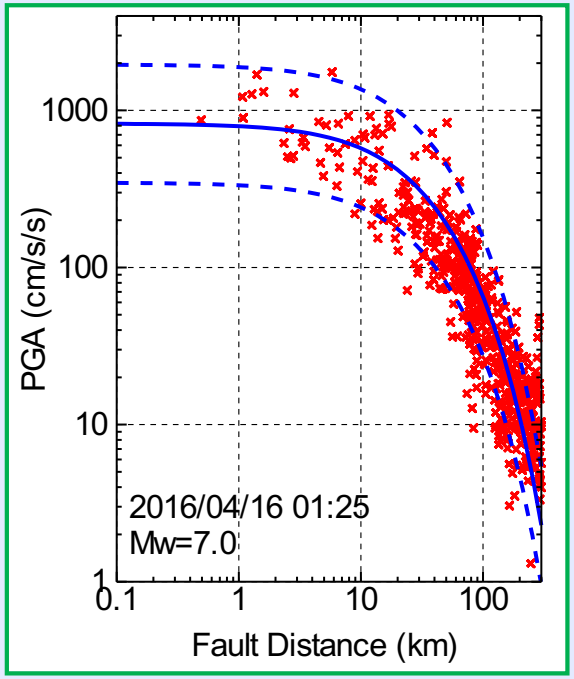
Yoshida et al., 2016
Waveform Inversion

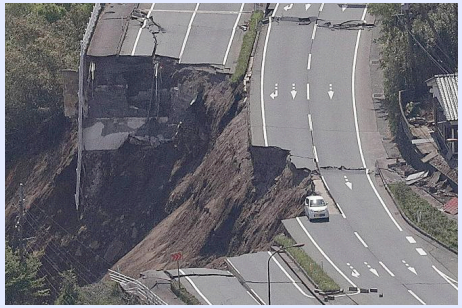


Somei et al., 2016
Modeling Using Empirical GFs



GMPE Japan



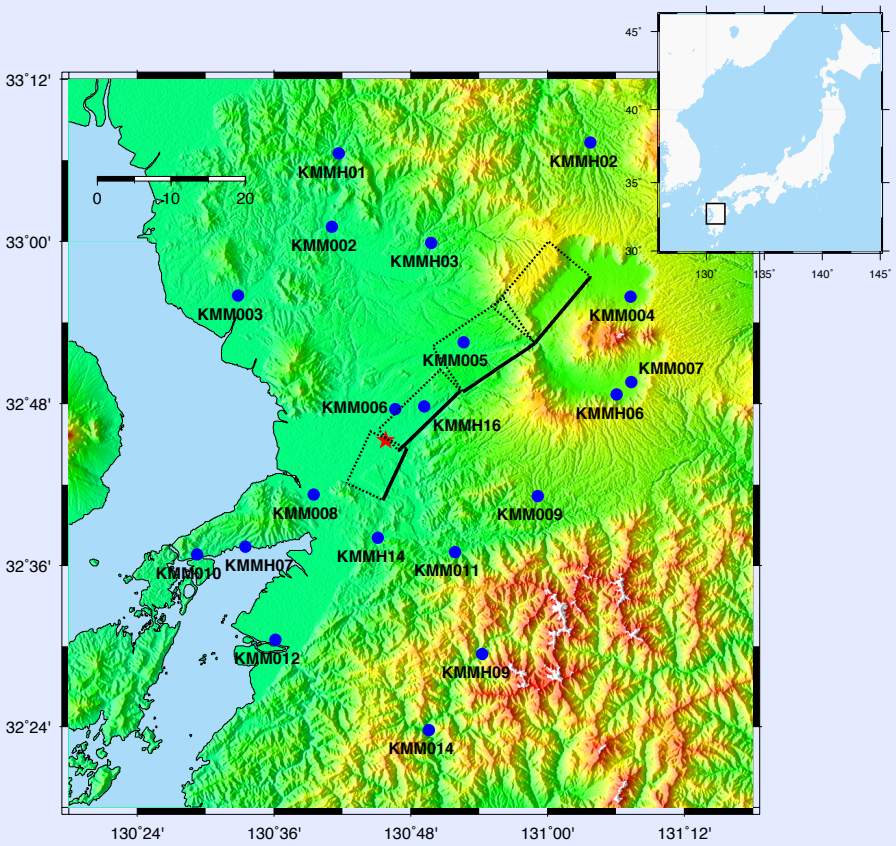


145 dead; 8329 collapsed houses

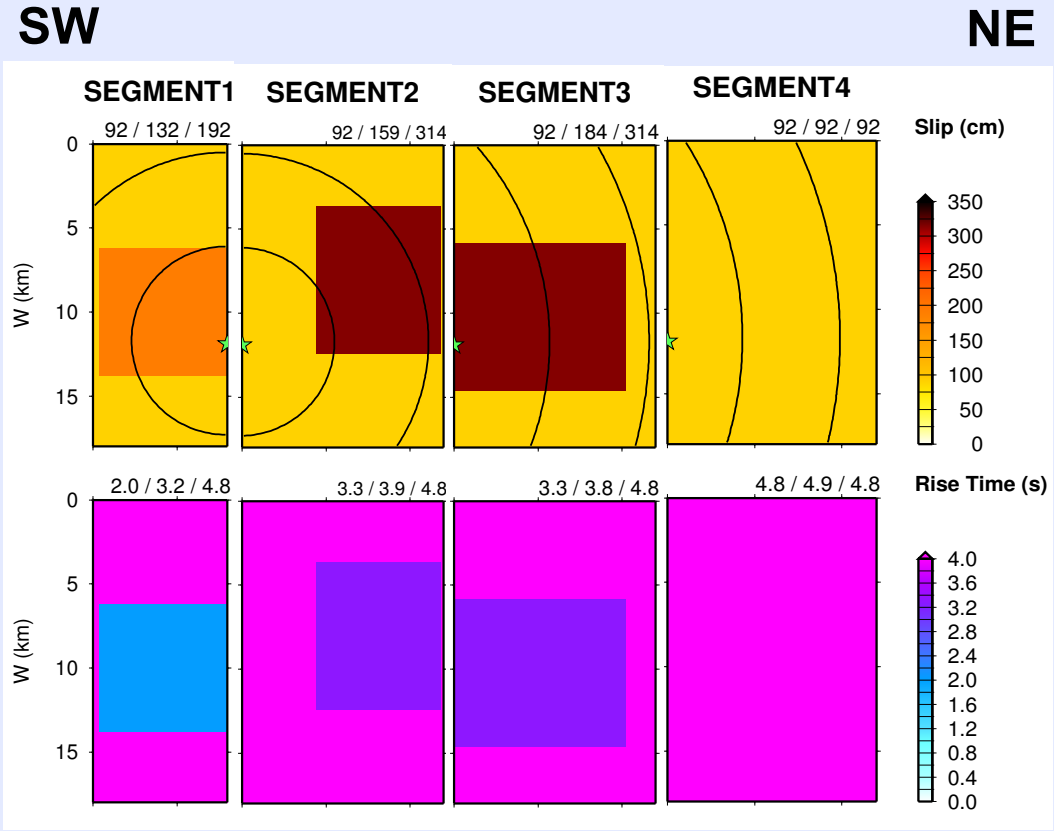
Characterized Kinematic Rupture Model
Irikura Recipe (Irikura and Miyake,2011)

Irikura et al., 2018

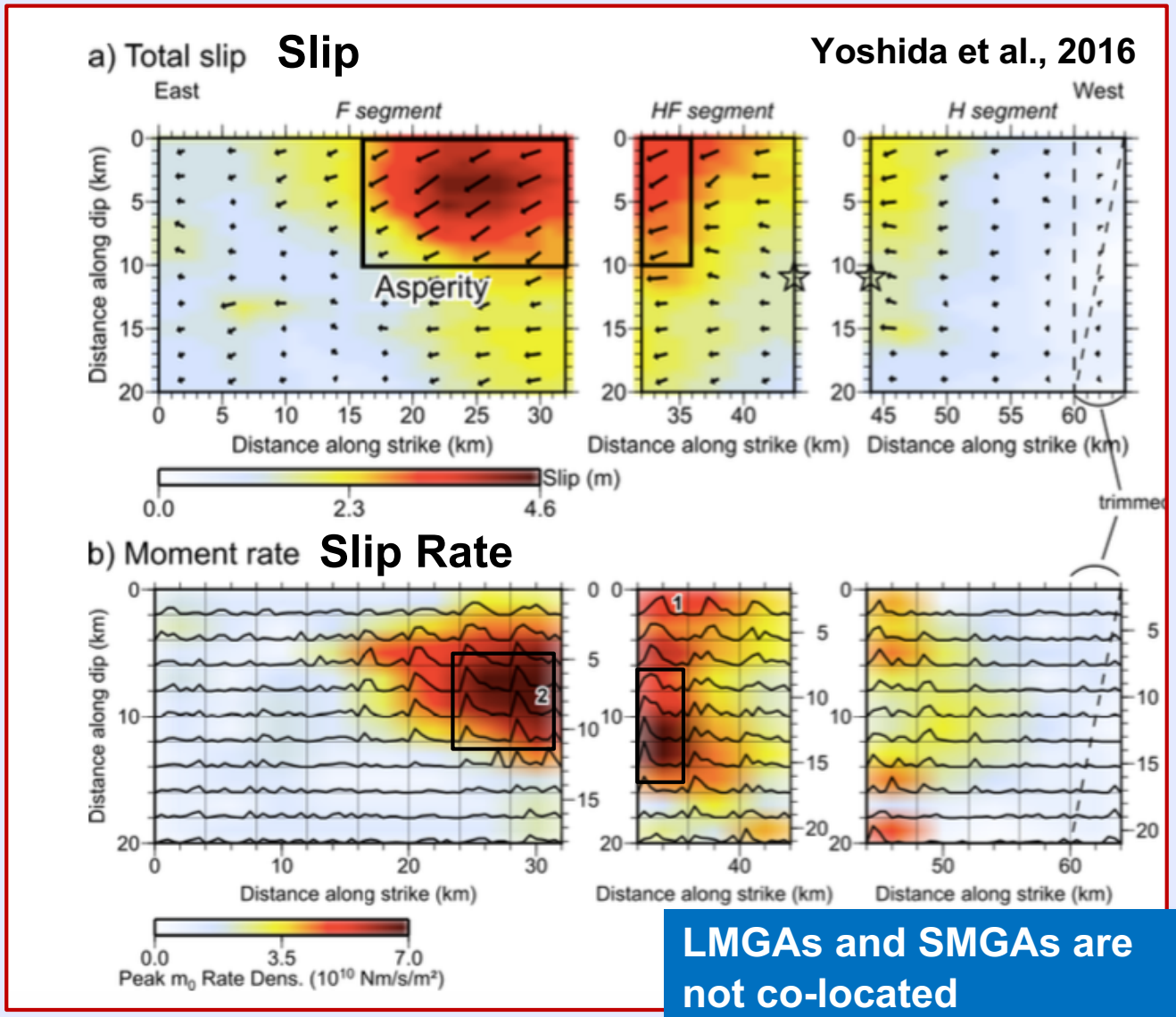
Fault Segmentation (Yoshida, 2016)



SMGAs location (Somei et al., 2017)



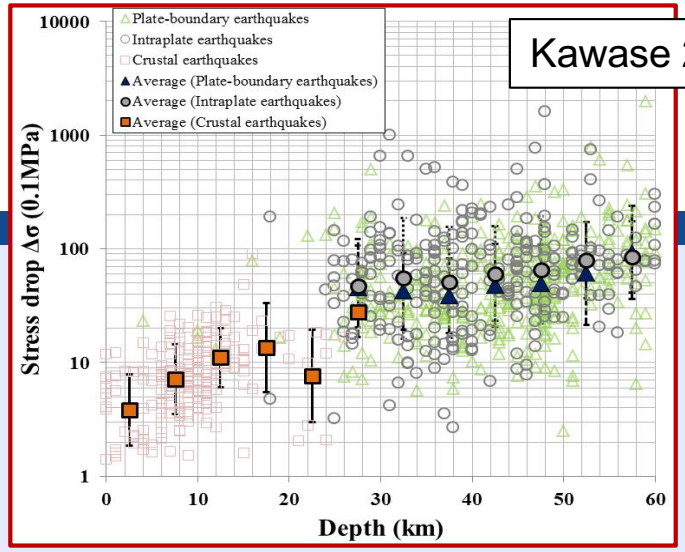
Separation of Large Slip Areas (LMGAs) from Large Slip Rate Areas(SMGAs)



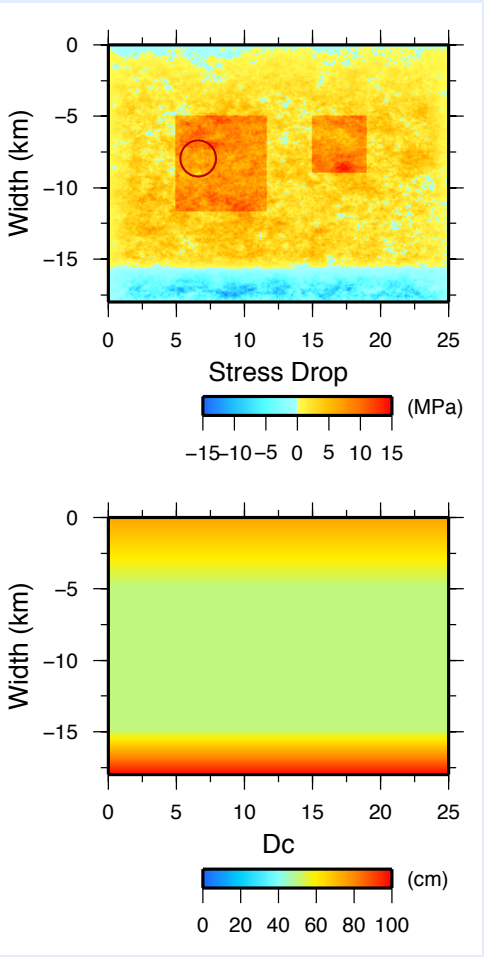
LMGAs and SMGAs are not co-located

Surface Displacement

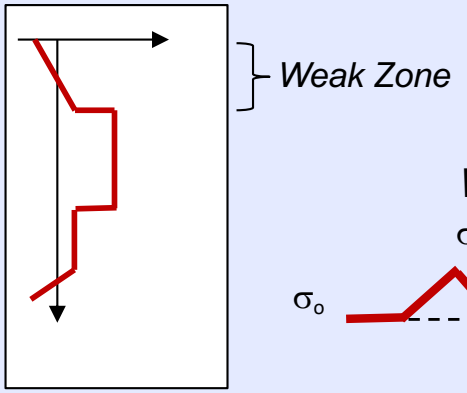
Spontaneous Rupture Modeling
Split Node Method (Dalguer and Day 2017)



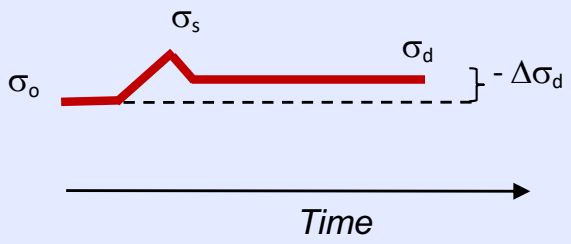
Av. Str.Drop 3MPa
Asp. Str.Drop 11MPa



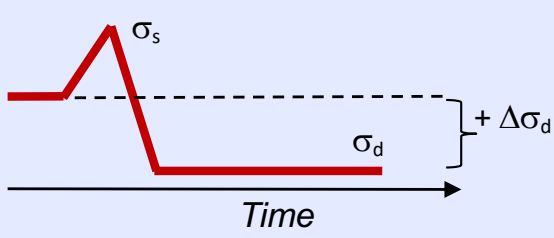
Stress Drop



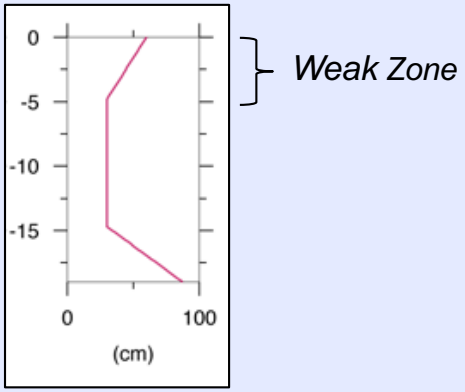
Weak Zone



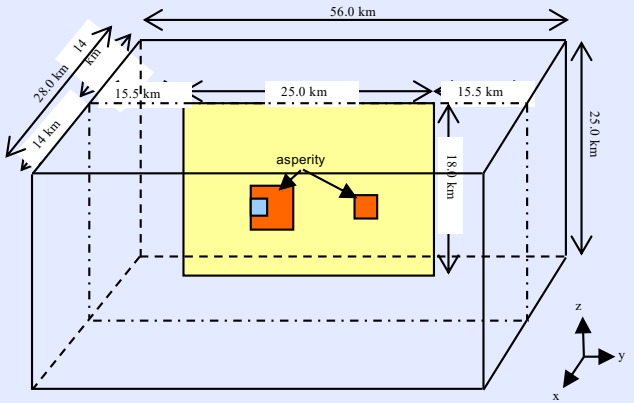
Asperity



D_c

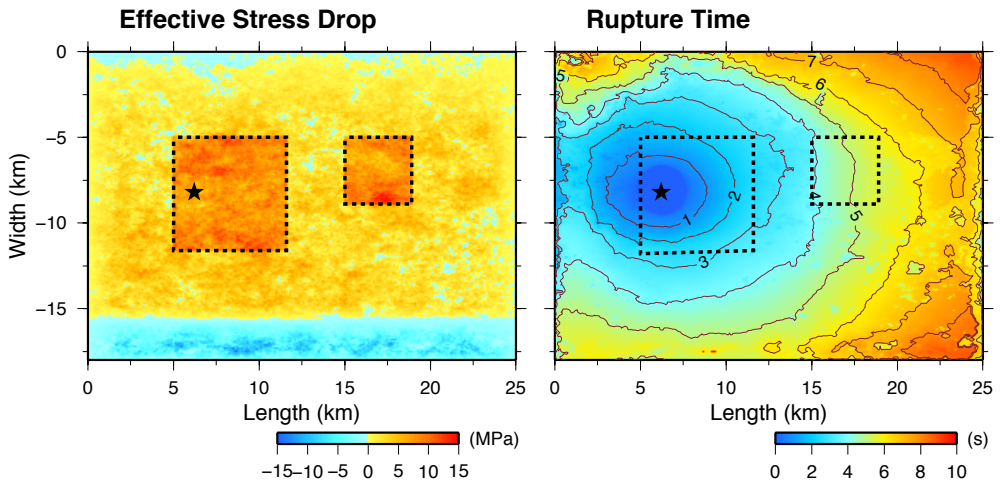


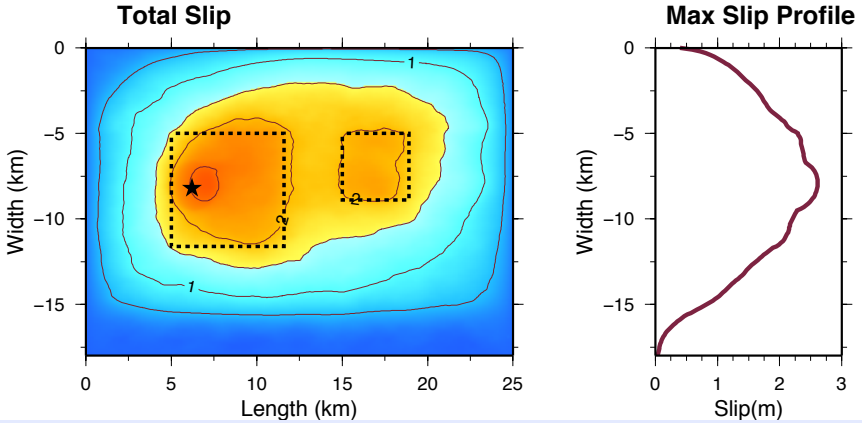
3D Staggered Grid 3DFDM (Pitarka, 1999)

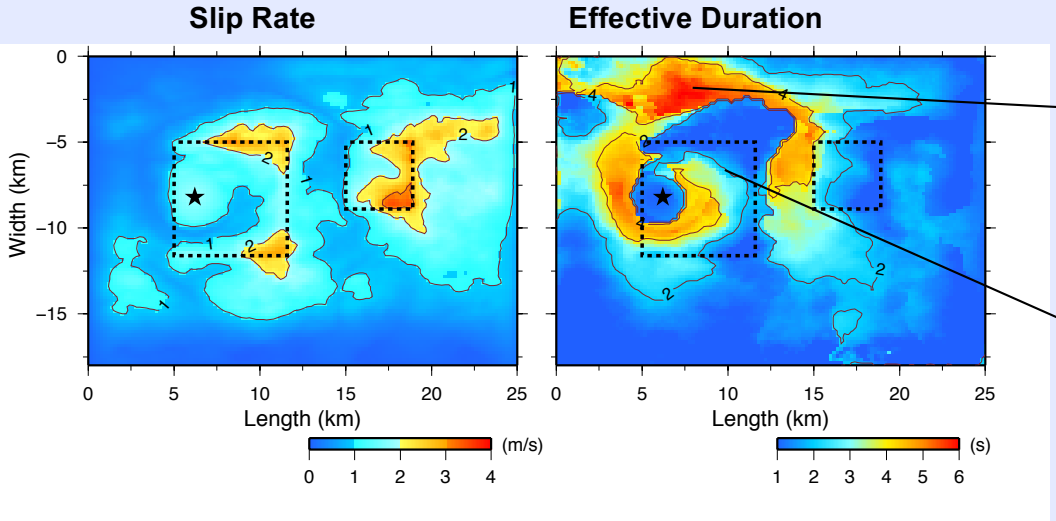


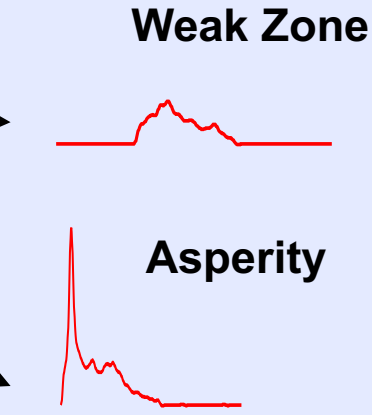
Grid spacing : 50 m
f_{max} : 2Hz

Kinematic Rupture Using Spontaneous Rupture Simulations f_{max}= 2Hz



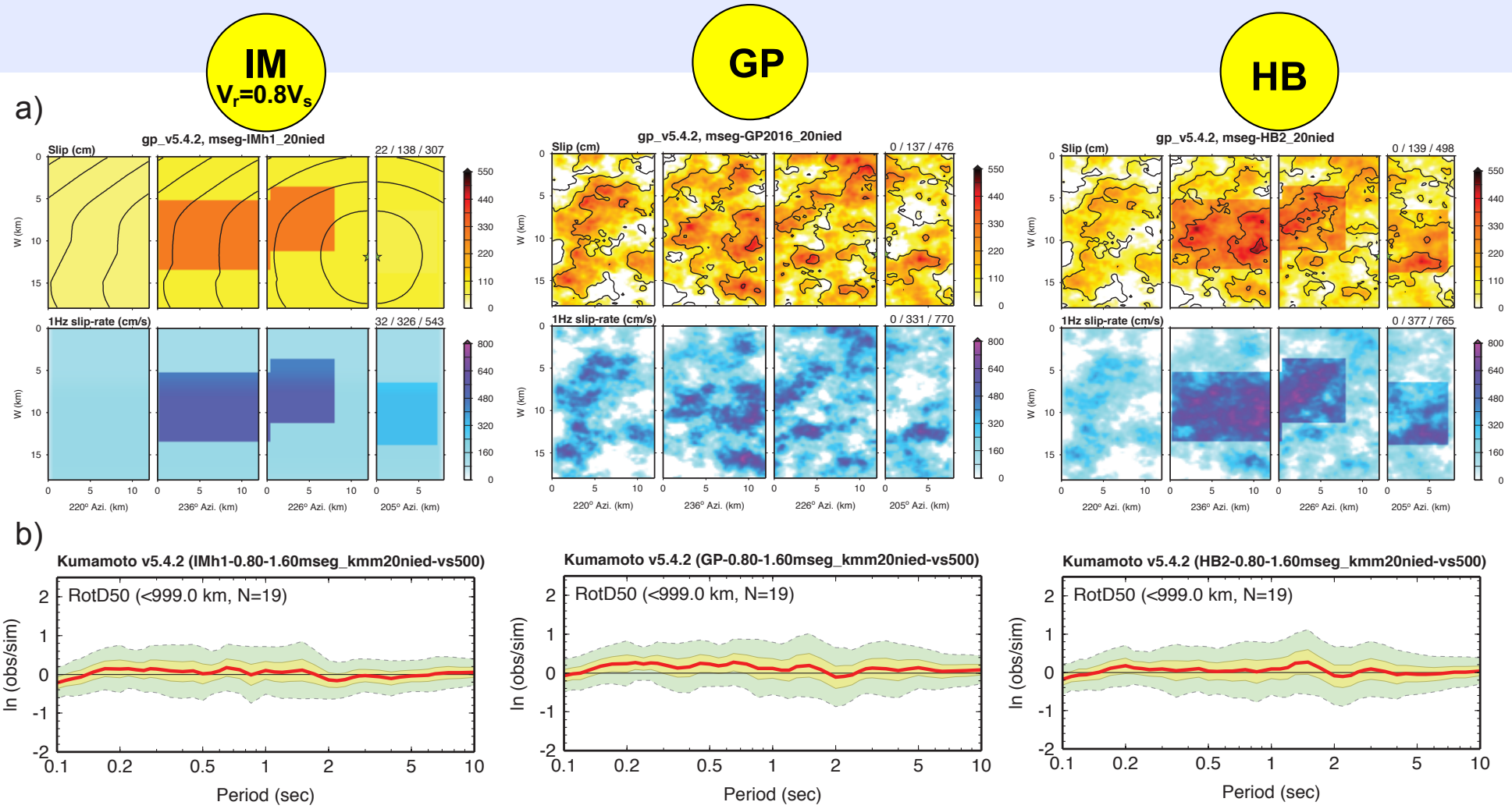






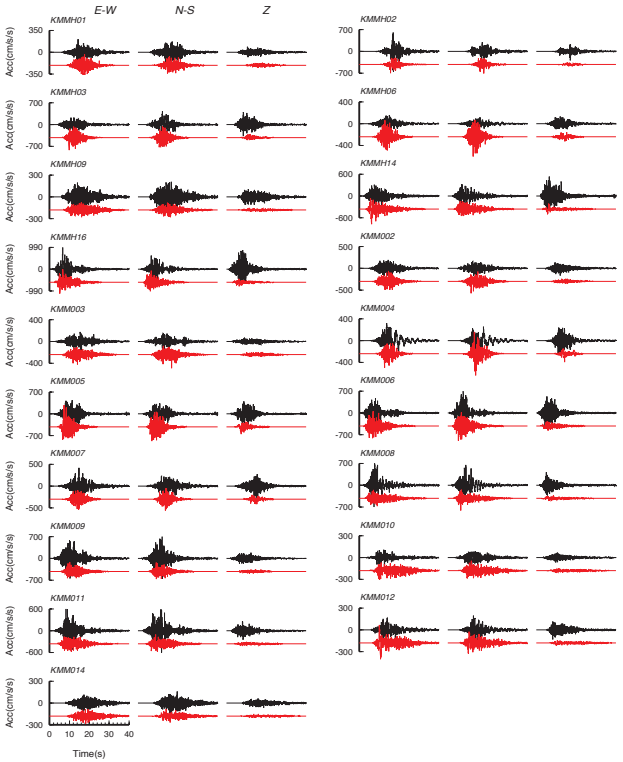
Performance of Rupture Models in Ground Motion Simulations Using GP BB Hybrid Method (0-10Hz)

Pitarka et al., 2019

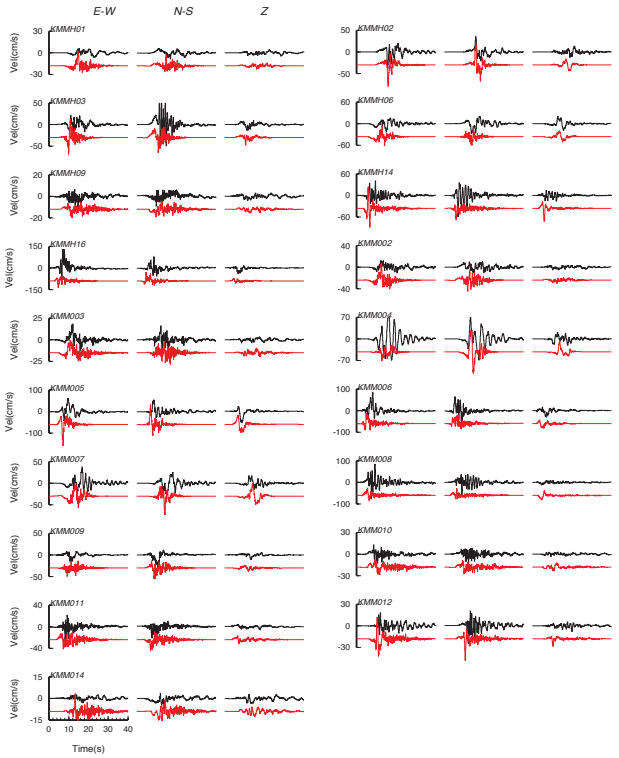


Ground Motion Simulated With HB Rupture Model

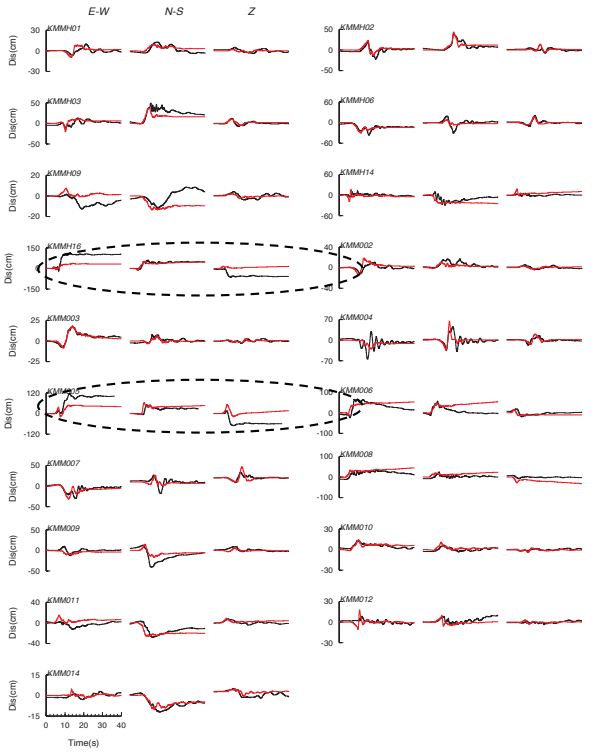
Acceleration



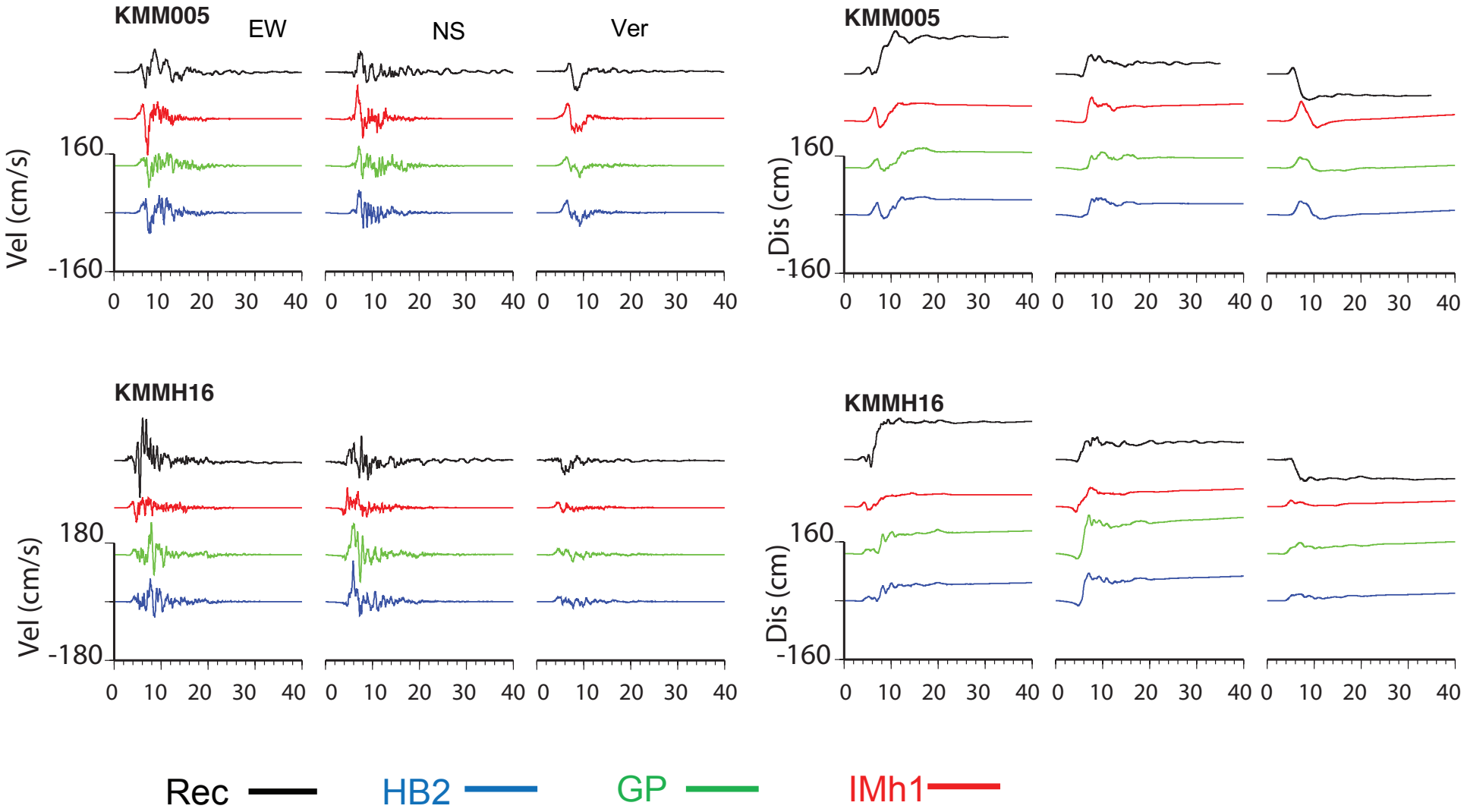
Velocity



Displacement

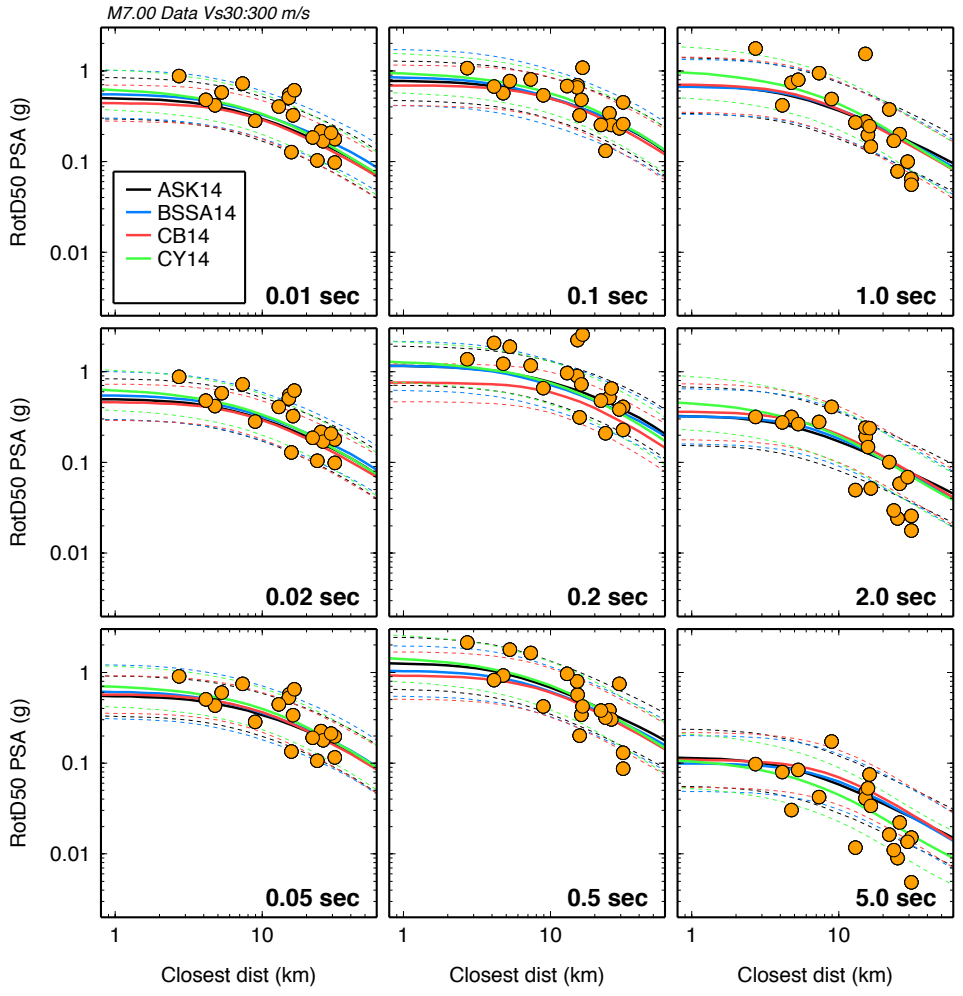


Waveforms at Near-fault Stations (0-10Hz)

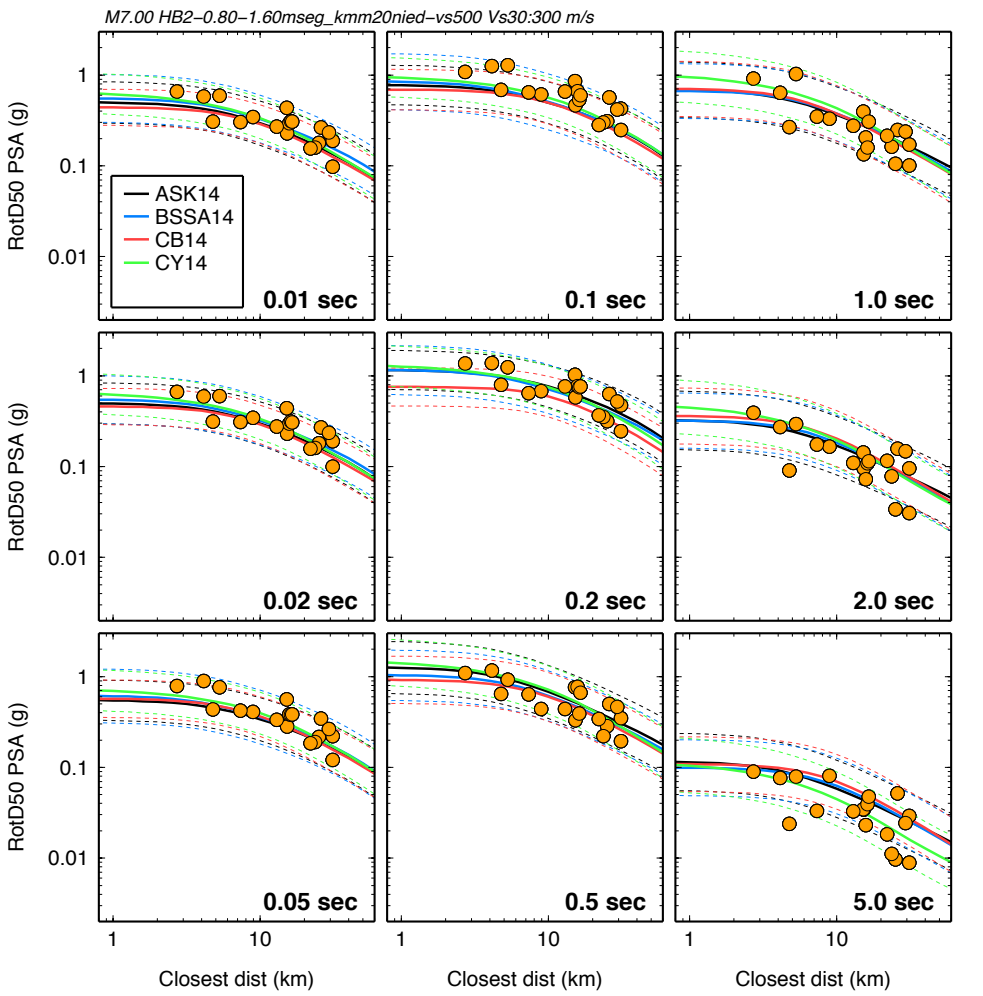


Comparisons with GMPEs

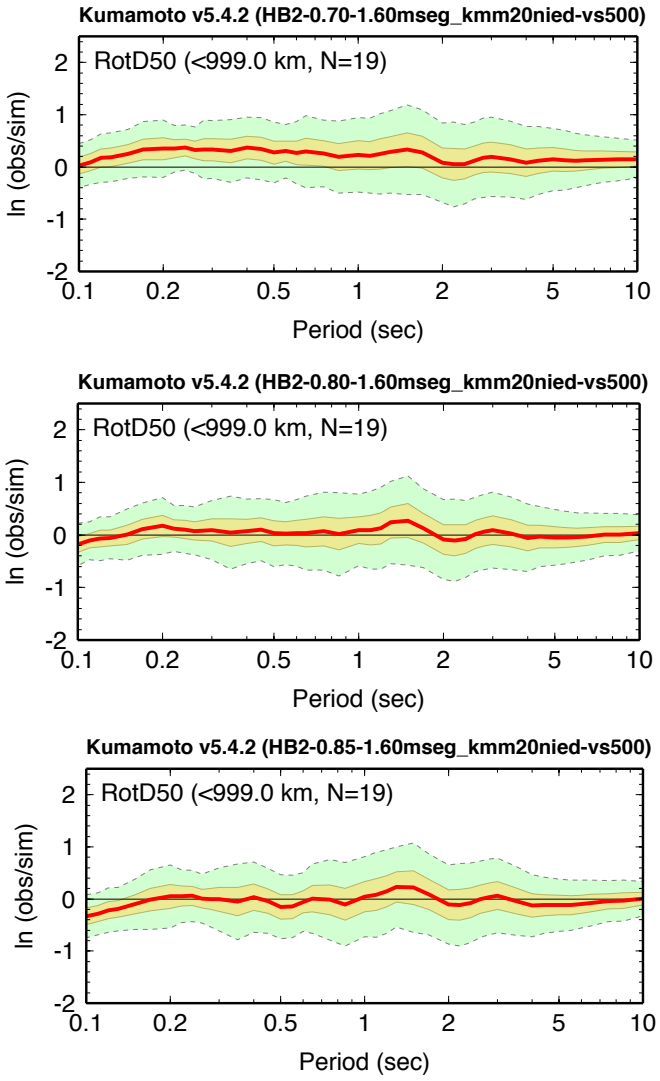
Recorded Data

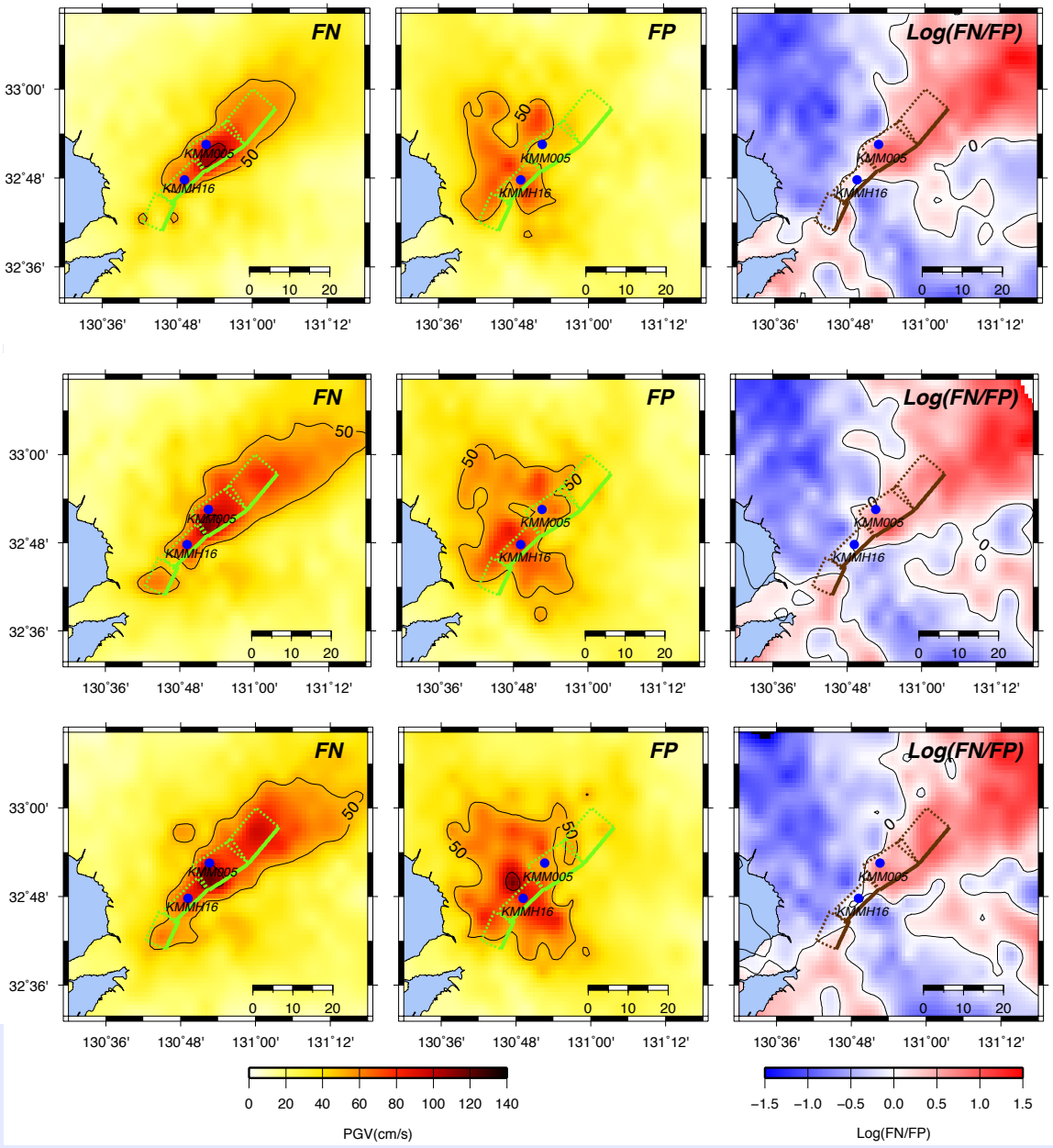


HB2 Simulation



Effects of Rupture Velocity





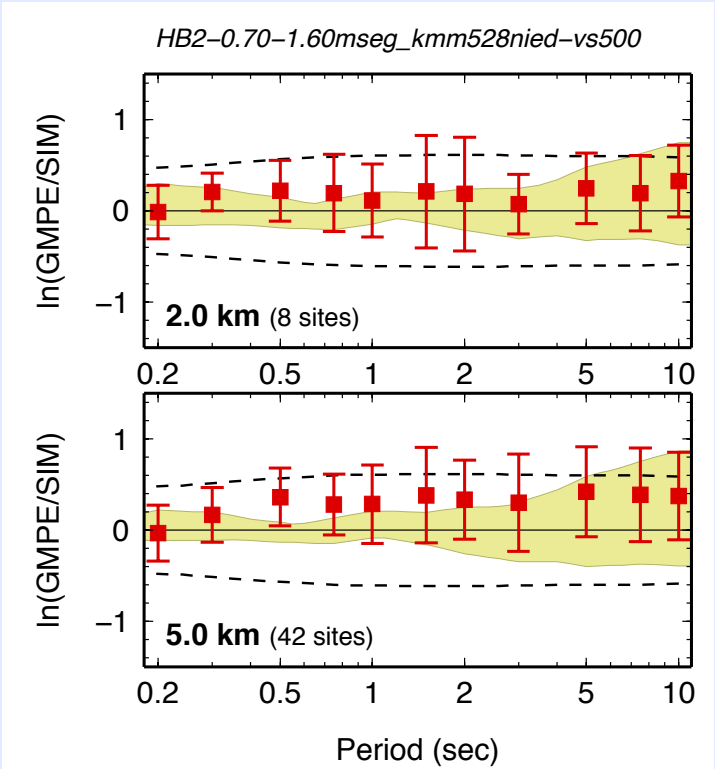
Vr/Vs=0.7
Risetime
Coeff=1.6

Vr/Vs=0.8
Risetime
Coeff=1.6

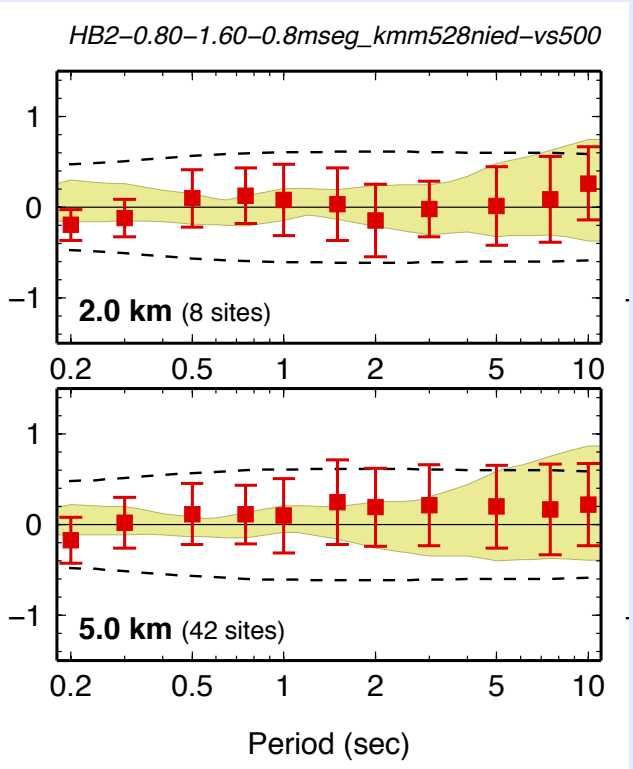
Vr/Vs=0.85
Risetime
Coeff=1.6

Intra-event Ground Motion Variability

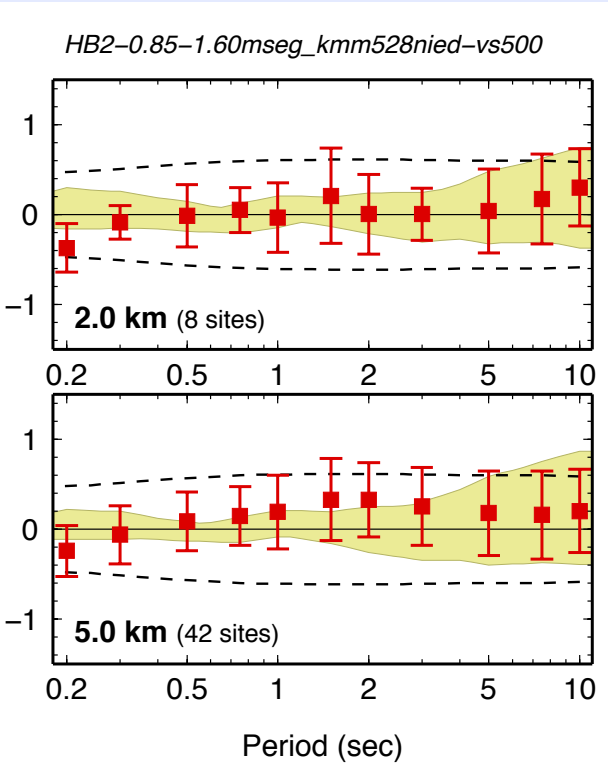
V_r/V_s=0.70



V_r/V_s=0.80



V_r/V_s=0.85



Intra-event variability is dependent on rupture velocity

Conclusions

1. Rupture dynamics using stress drop models incorporating asperity areas with shallow weak zone can explain the spatial separation between shallow areas with large slip and deeper areas of large slip rate observed during the Kumamoto earthquake

2. These features are likely to be typical characteristics of large crustal earthquakes. They affect both long and short period content of near-fault ground motion.

3. Sensitivity analysis with kinematic rupture models indicate that the average rupture velocity is an important parameter that affects the ground motion amplitude and its intra-event variability.

Thank You !

Related Recent Articles:

Pitarka A., R. Graves, K.Irikura, H. Miyake, and A. Rodgers (2017). Performance of Irikura Recipe Rupture Model Generator in Earthquake Ground Motion Simulations with Graves and Pitarka Hybrid Approach, *Pure and Applied Geophysics*, **174**(9), doi:10.1007/s00024-017-1504-3.

Pitarka A., R.Graves, K.Irikura, K. Miyakoshi, A. Rodgers. (2019). Kinematic Rupture Modeling of Ground Motion from the M7 Kumamoto, Japan Earthquake, *Pure and Applied Geophysics*. https://doi.org/10.1007/s00024-019-02220-5