

Simulation of a strong ground motion exceeding 4G during the 2008 Iwate- Miyagi Nairiku earthquake, Japan

by

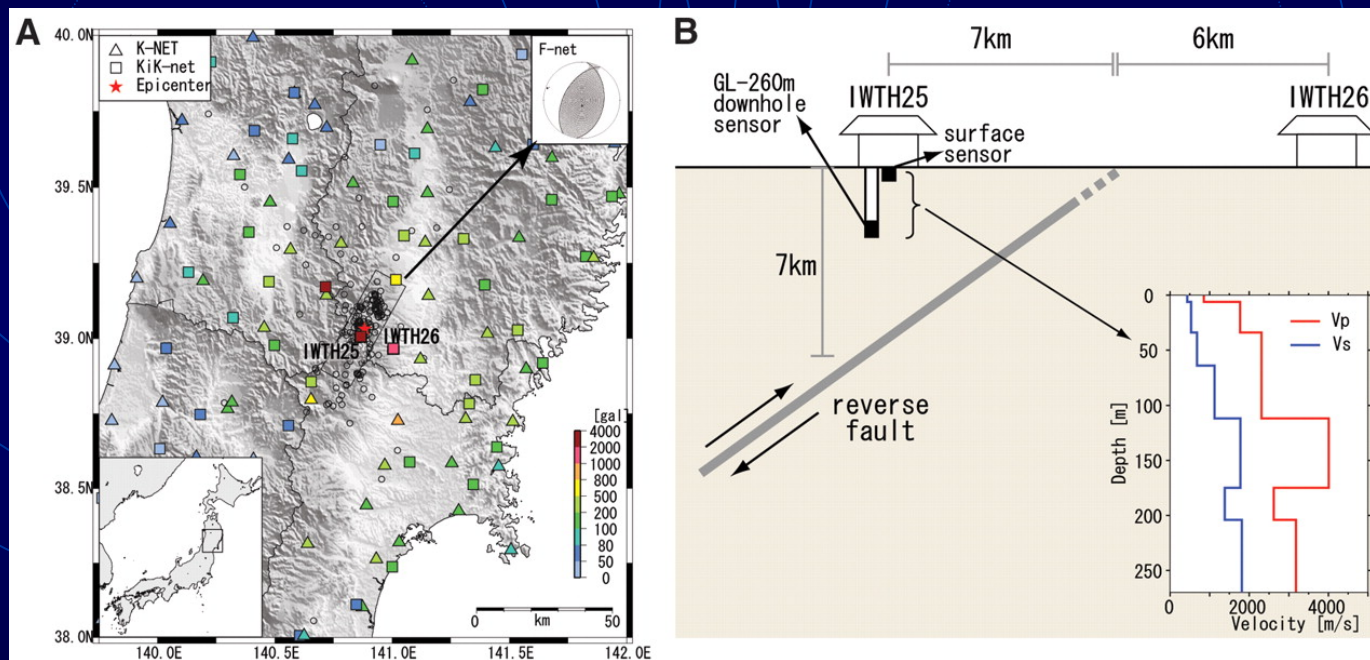
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Outline

1. Description of the extreme ground motions recorded during the Iwate-Miyagi Nairiku earthquake, Japan, at the West-Ichinoseki KiK-net station (IWITH25).
2. Investigation of the HF generation process of the earthquake.
3. Simulation of UD component of strong ground motion observed at the West Ichinoseki station.
4. Discussion and conclusions

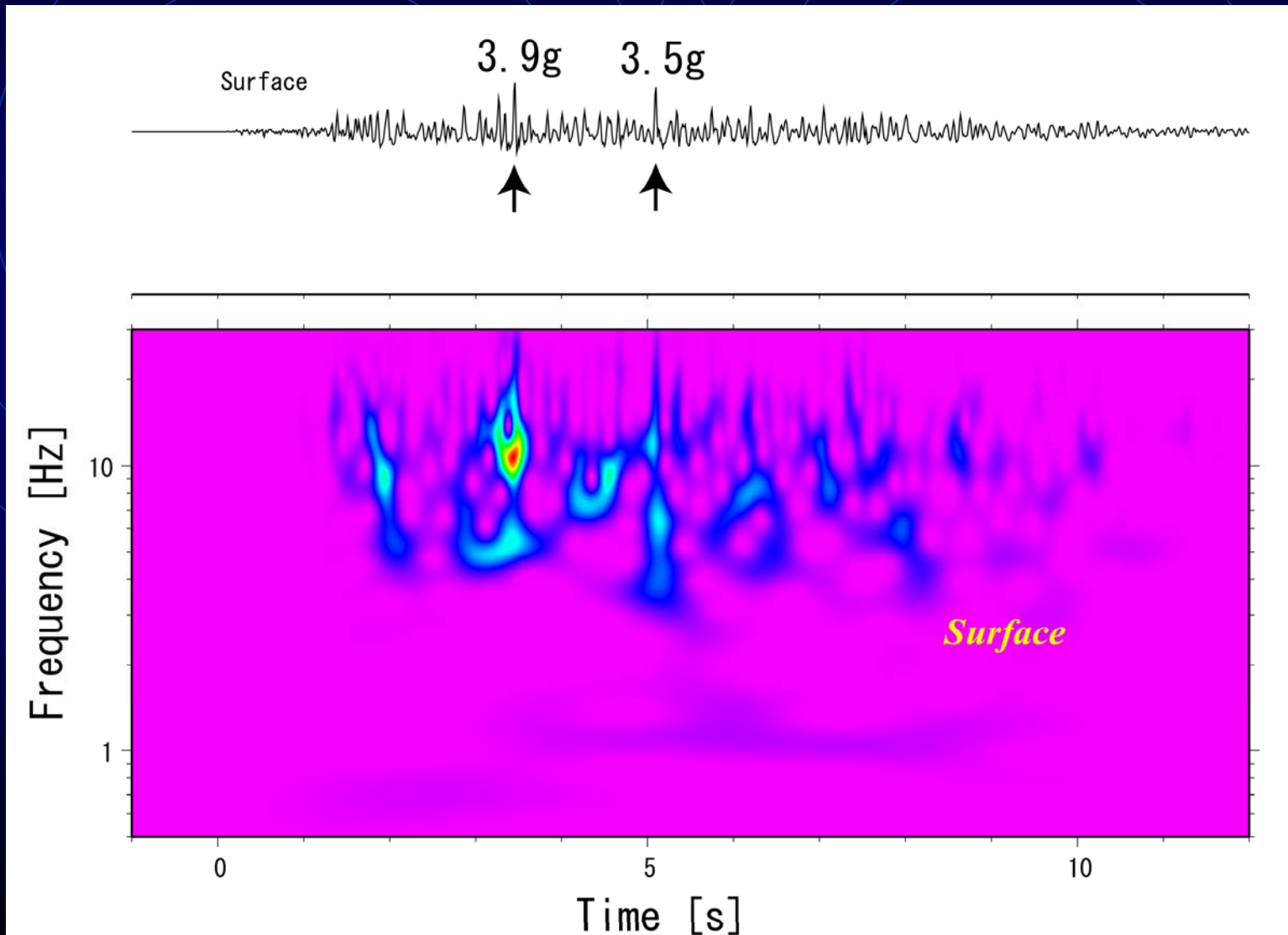
Map of the source region of the Iwate-Miyagi Nairiku earthquake in Japan [14 June 2008; moment magnitude (M_w) = 6.9]



Borehole accelerometer is located at –GL 260m
at an S-wave velocity layer of 1800 m/s

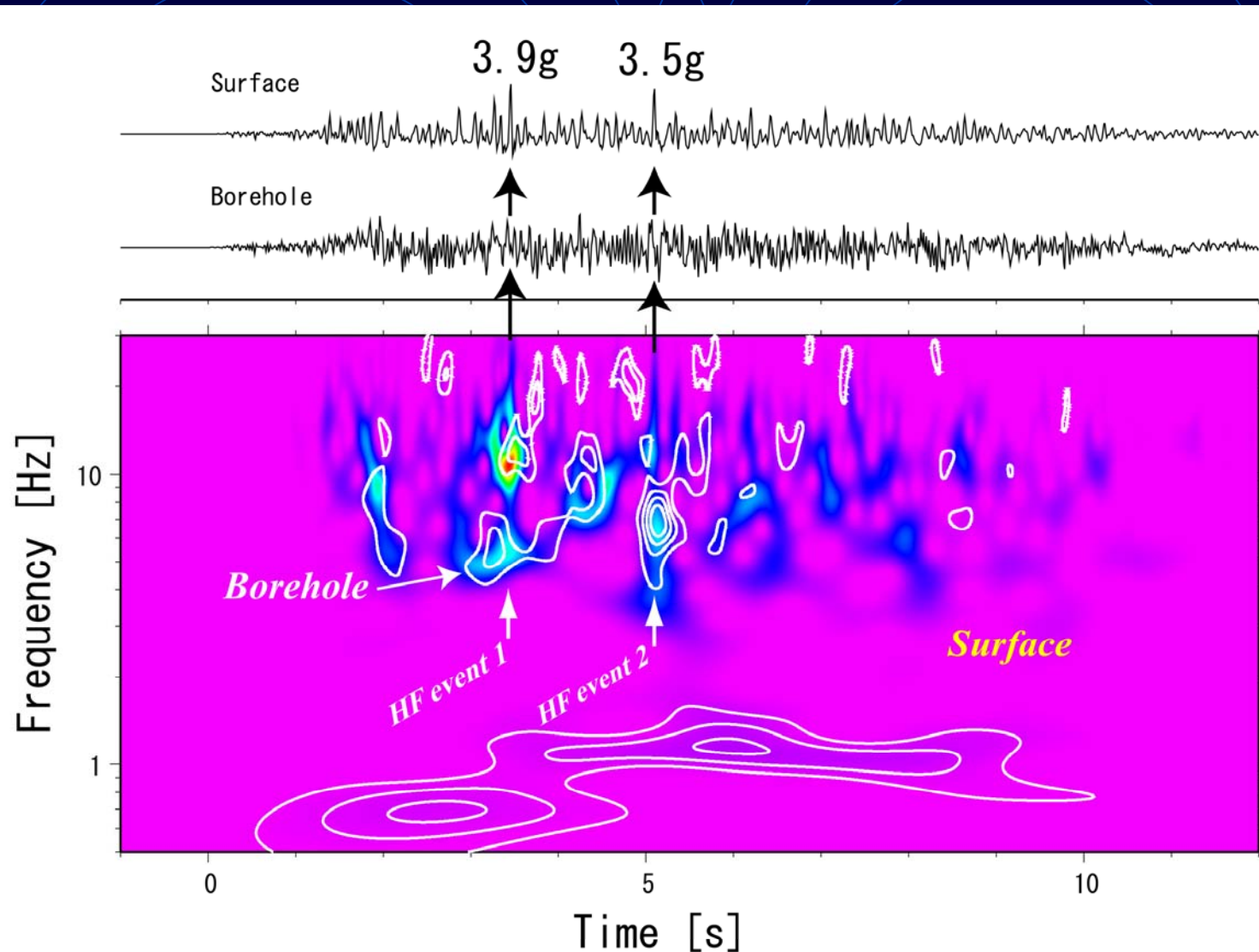
Time-frequency representation of observed UD component (surface and borehole) at IWTH25

(bandpass filter 0.1-30Hz)

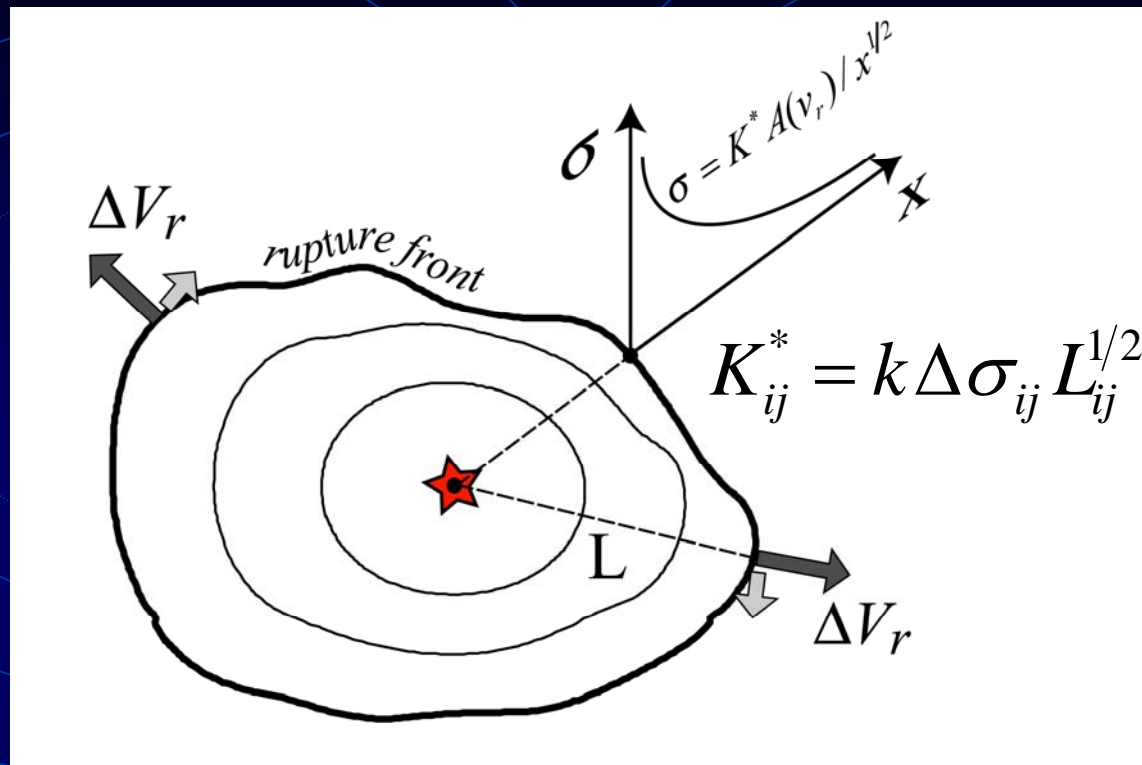


Time-frequency representation of observed UD component (surface and borehole) at IWTH25

(bandpass filter 0.1-30Hz)



High frequency radiation model

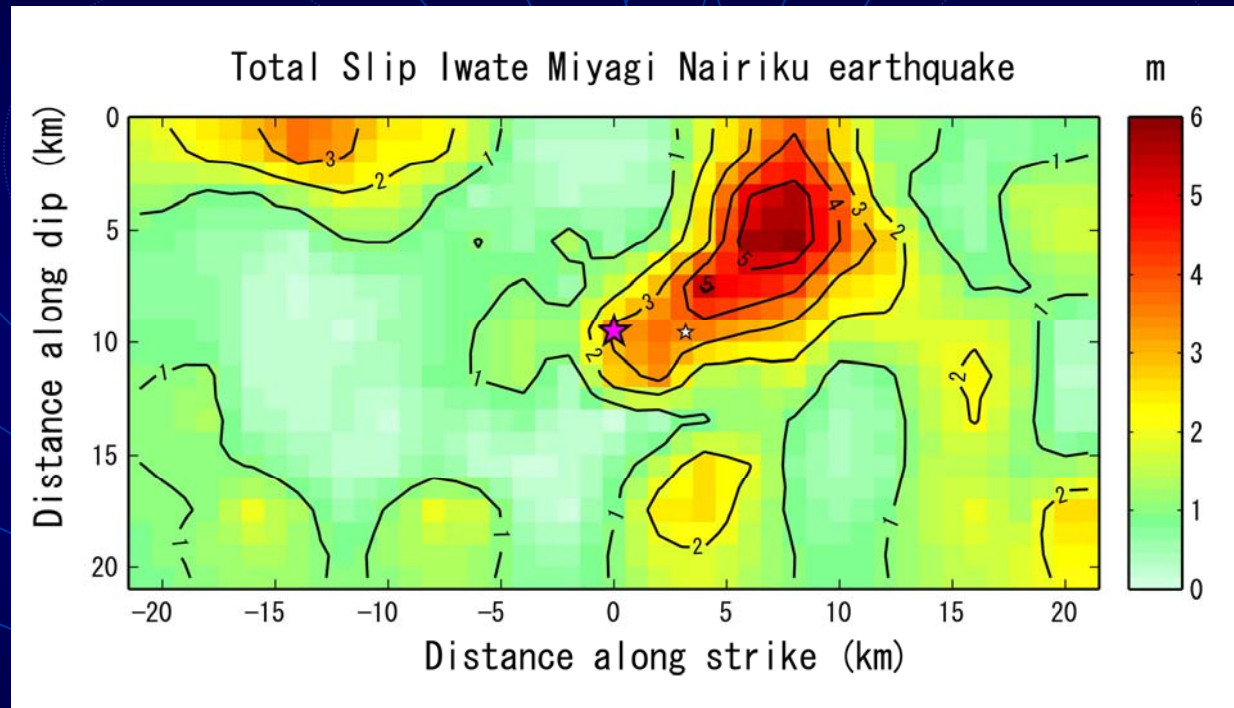


$$\Omega_{ij} = K_{ij}^* \Delta V_{r\ ij}$$

$$a_{ijk}^m(f) = \frac{R_{\theta\phi\psi}^m D \Omega_{ij} e^{\pi f R_{ijk} / Q(f) \beta} P(f) C_I F^e}{R_{ijk} L_{ij}^{-1/2} \rho \beta^2} E(f)$$

High frequency radiation model based on Pulido and Dalguer (2008, in review) ⁶

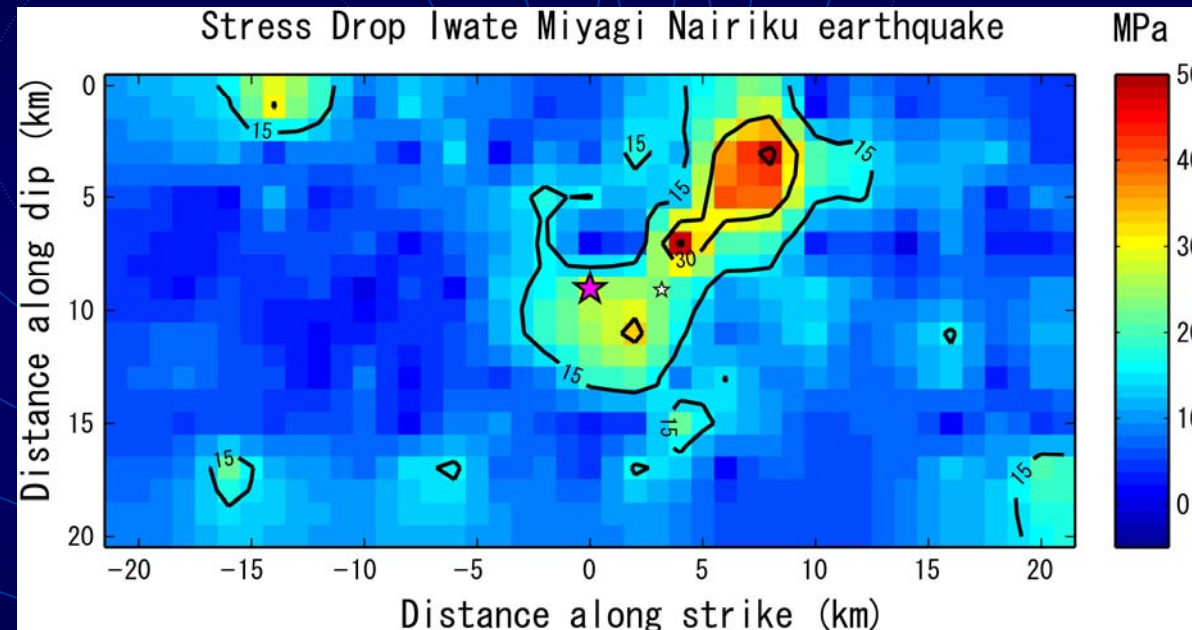
Slip model of the 2008 Iwate-Miyagi Nairiku earthquake



Maximum slip 5.7m
average rupture velocity 1.8 km/s

Slip model by Suzuki et. al 2008 (AGU Fall meeting)

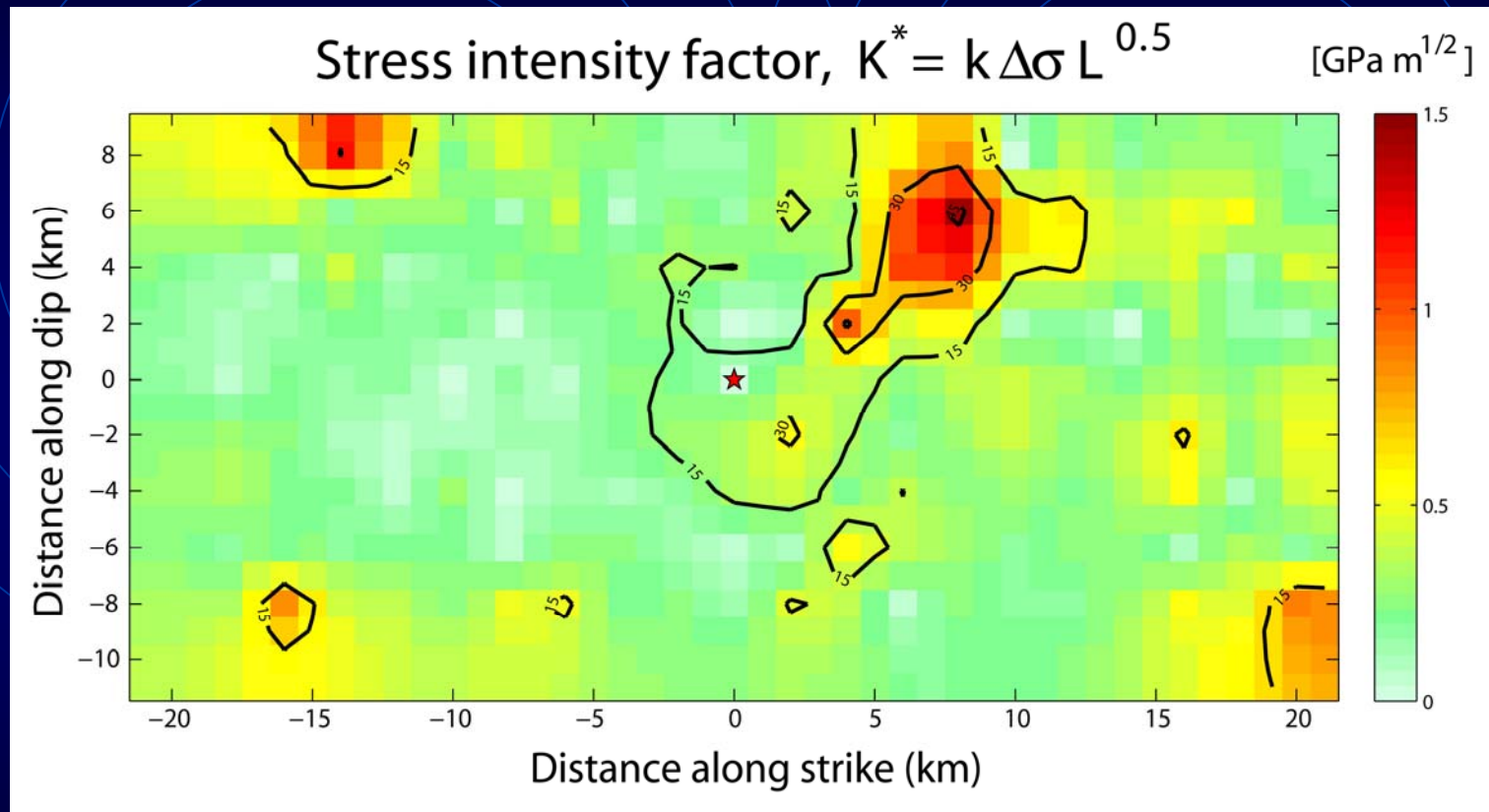
Stress drop of the 2008 Iwate-Miyagi Nairiku earthquake



Maximum stress drop ~ 50MPa

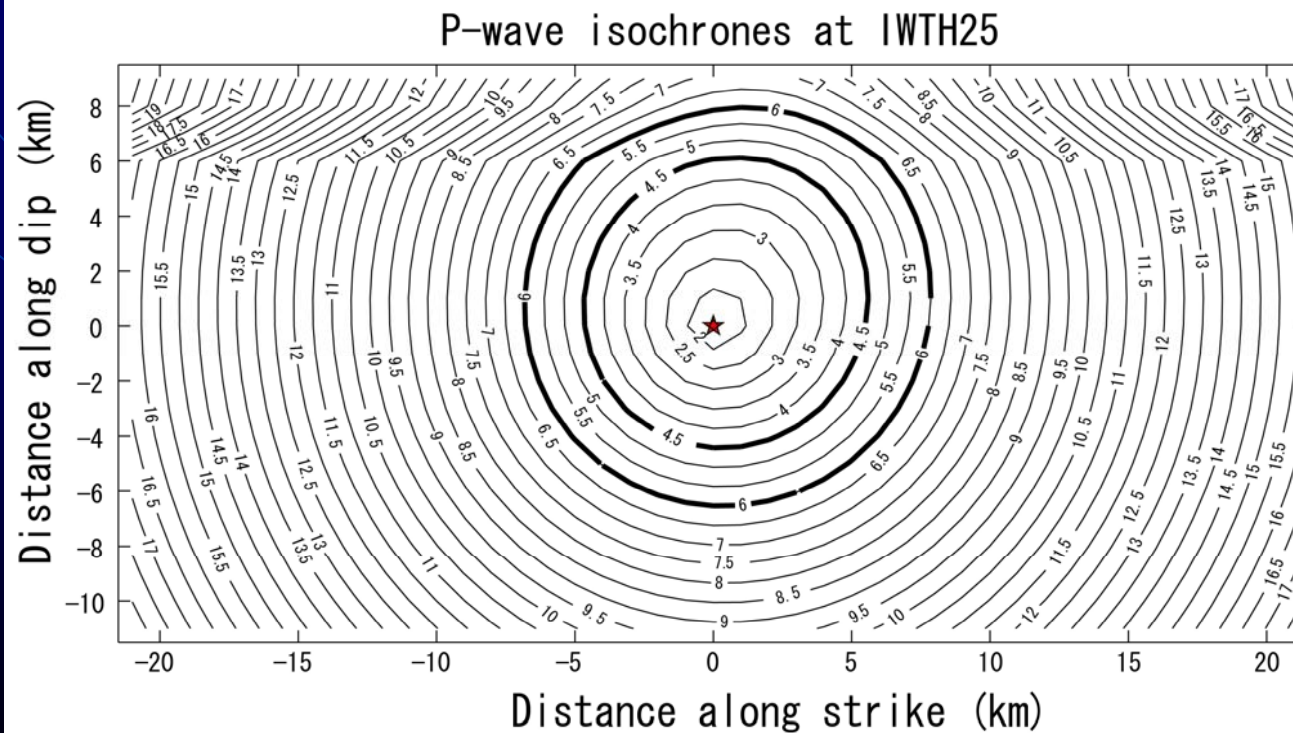
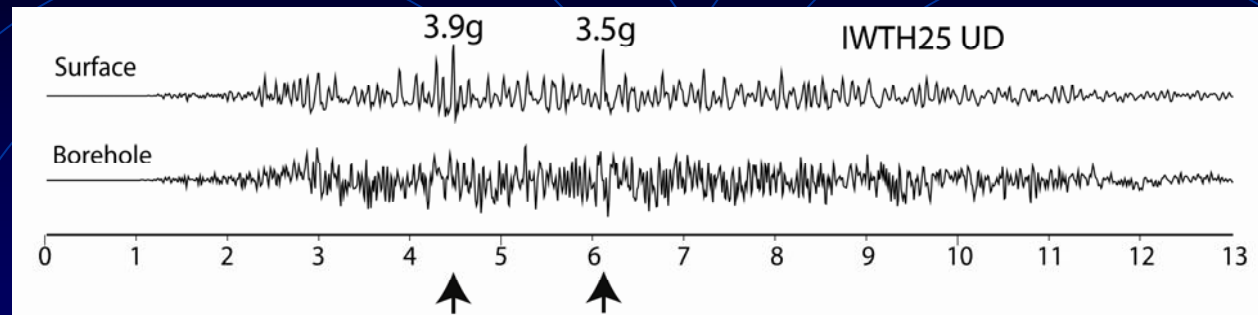
Stress drop calculated using Ripperger and Mai 2004

Stress intensity factor distribution of the 2008 Iwate-Miyagi Nairiku earthquake



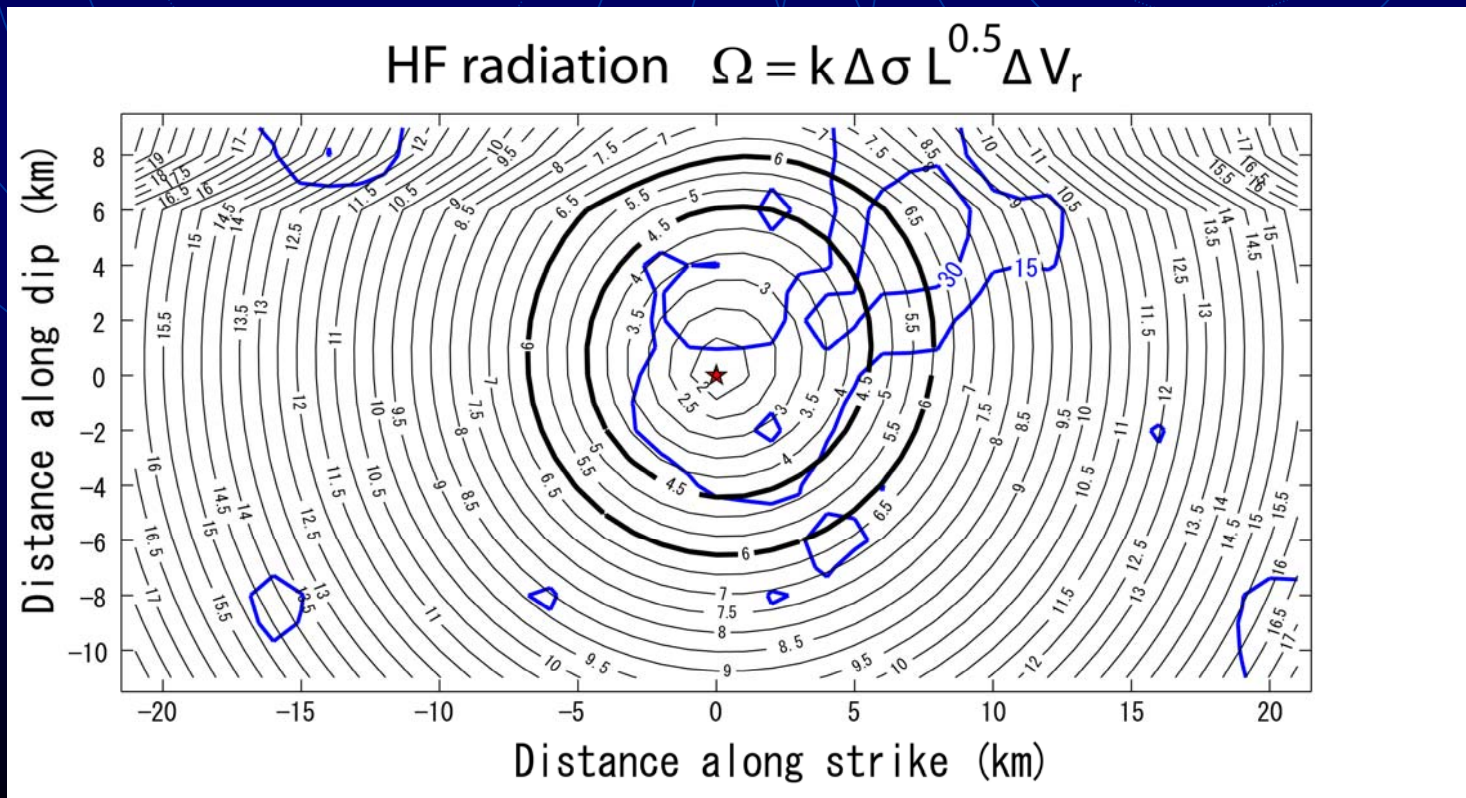
$k = 0.5$, average value for circular cracks [Madariaga 1977]

High frequency radiation model of the 2008 Iwate-Miyagi Nairiku earthquake

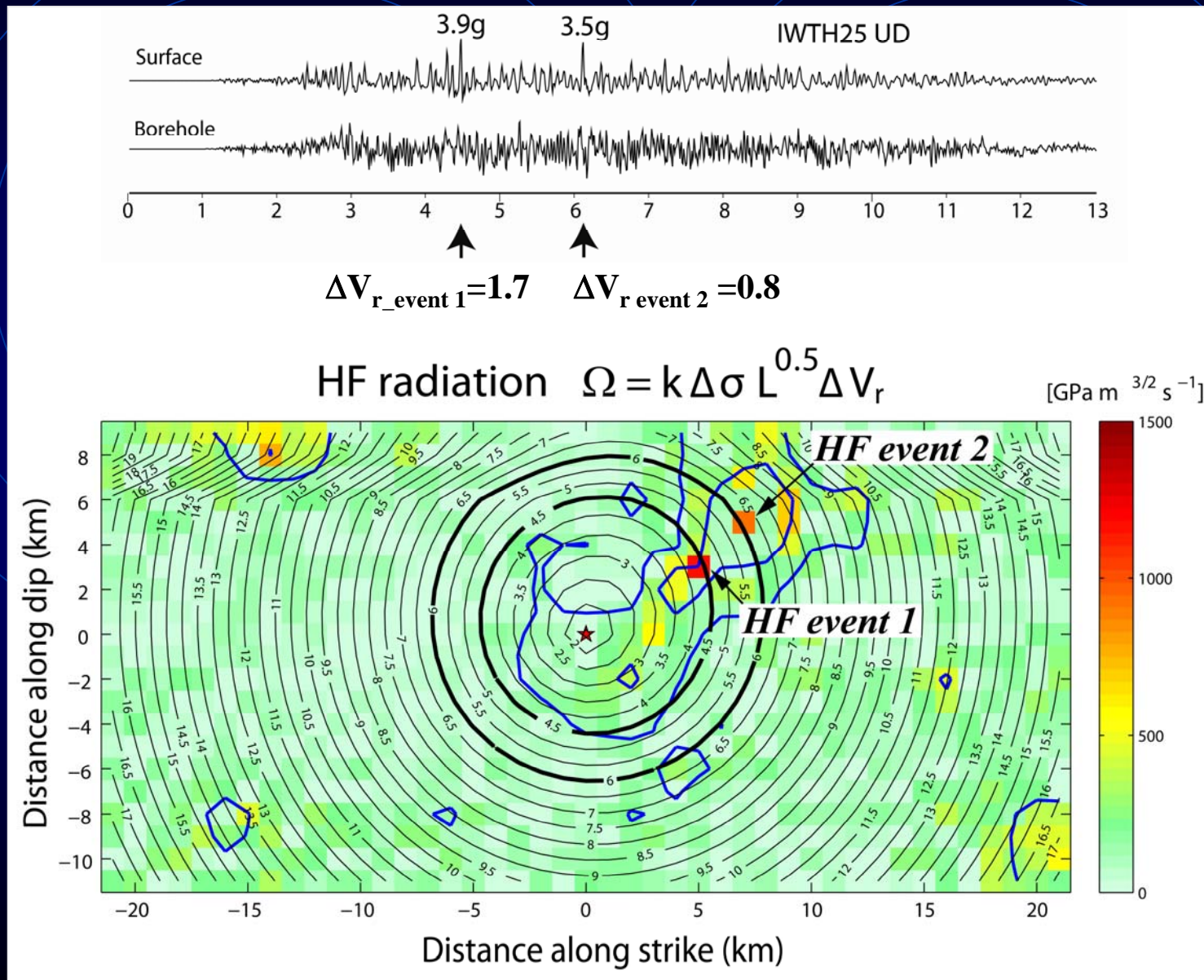


High frequency radiation model of the 2008 Iwate-Miyagi Nairiku earthquake

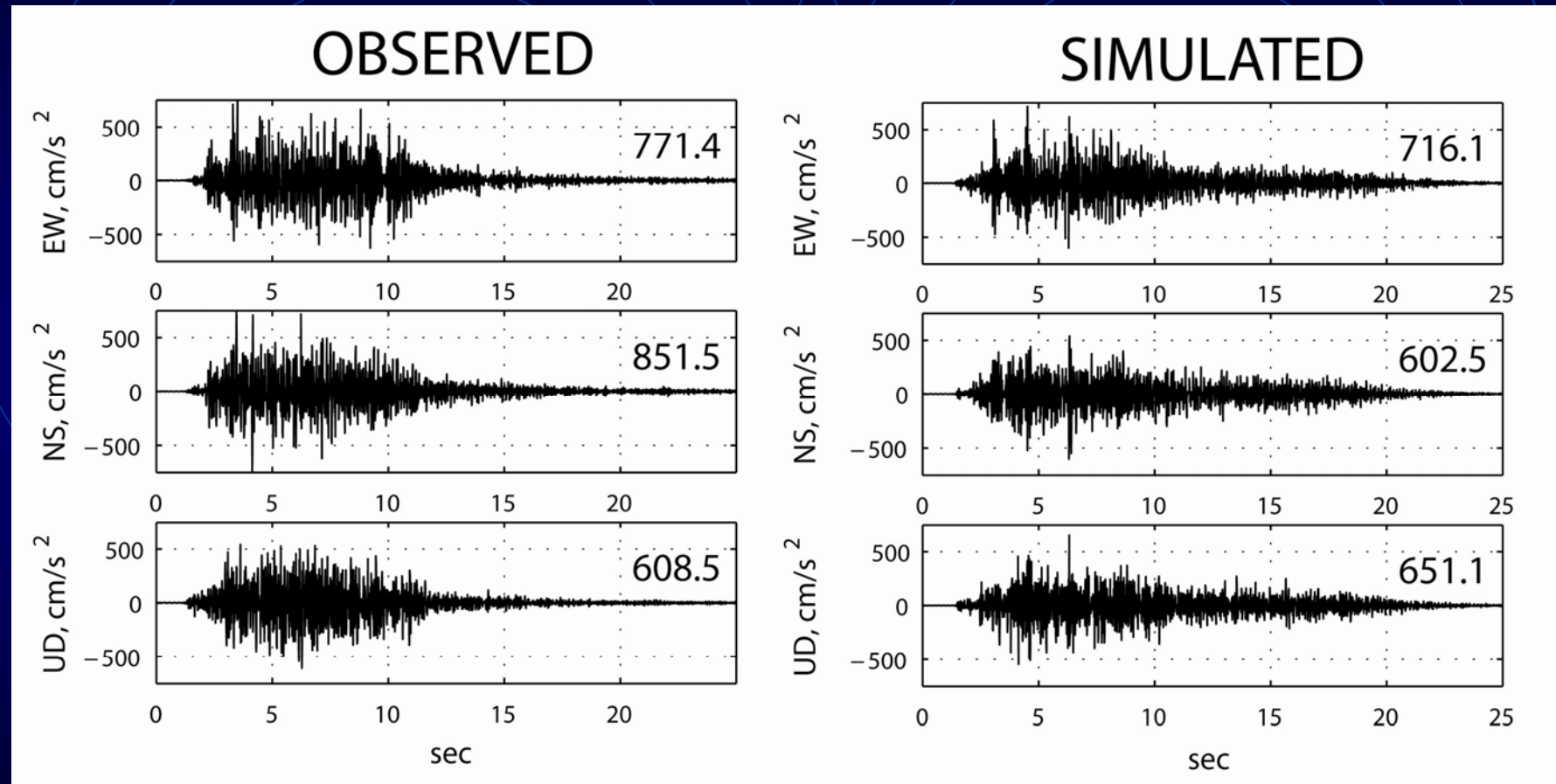
High frequency is generated within regions with large stress intensity factors (large stress drops) as well as strong rupture velocity changes across the fault (Pulido and Dalguer 2008)



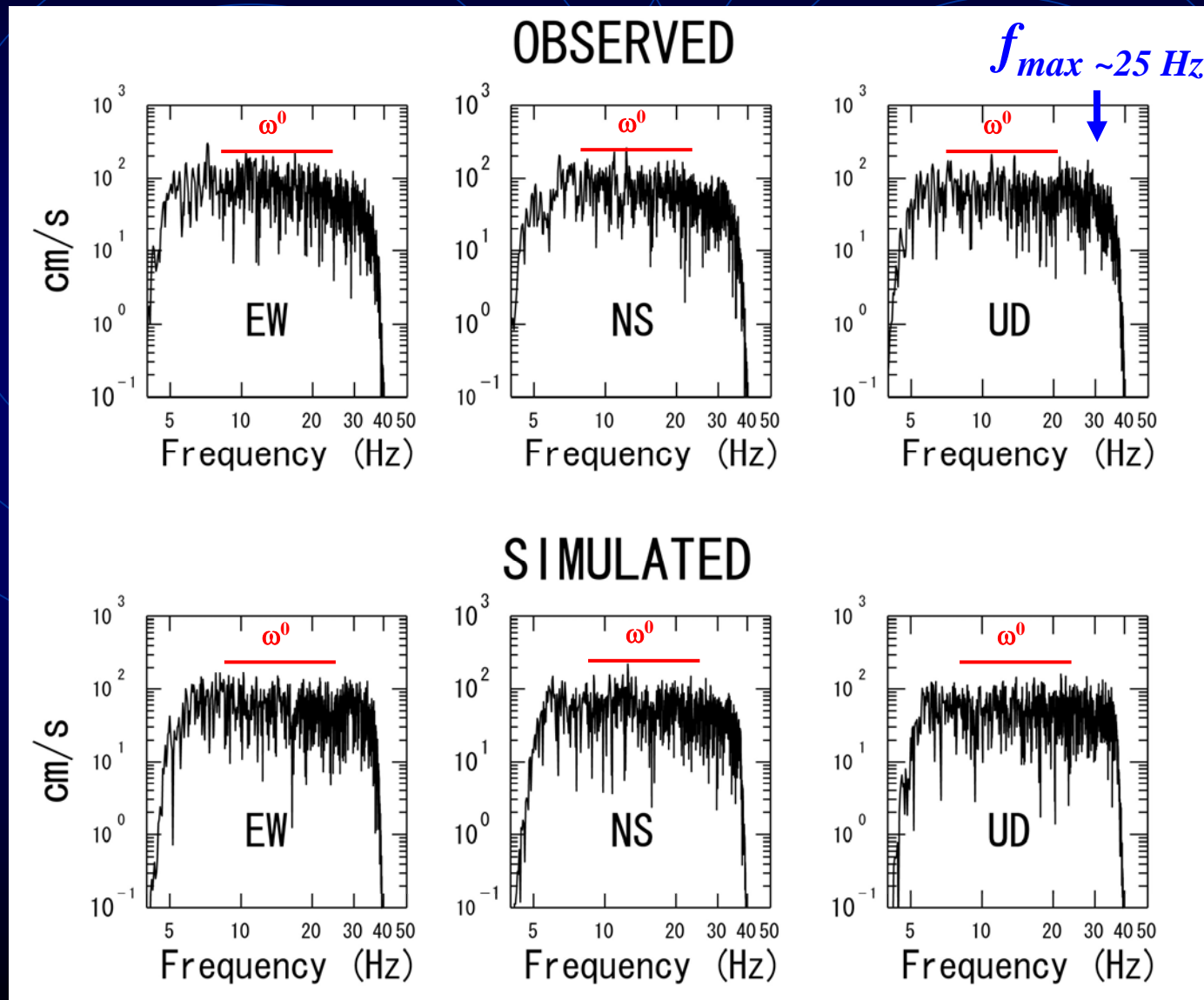
High frequency radiation model of the 2008 Iwate-Miyagi Nairiku earthquake



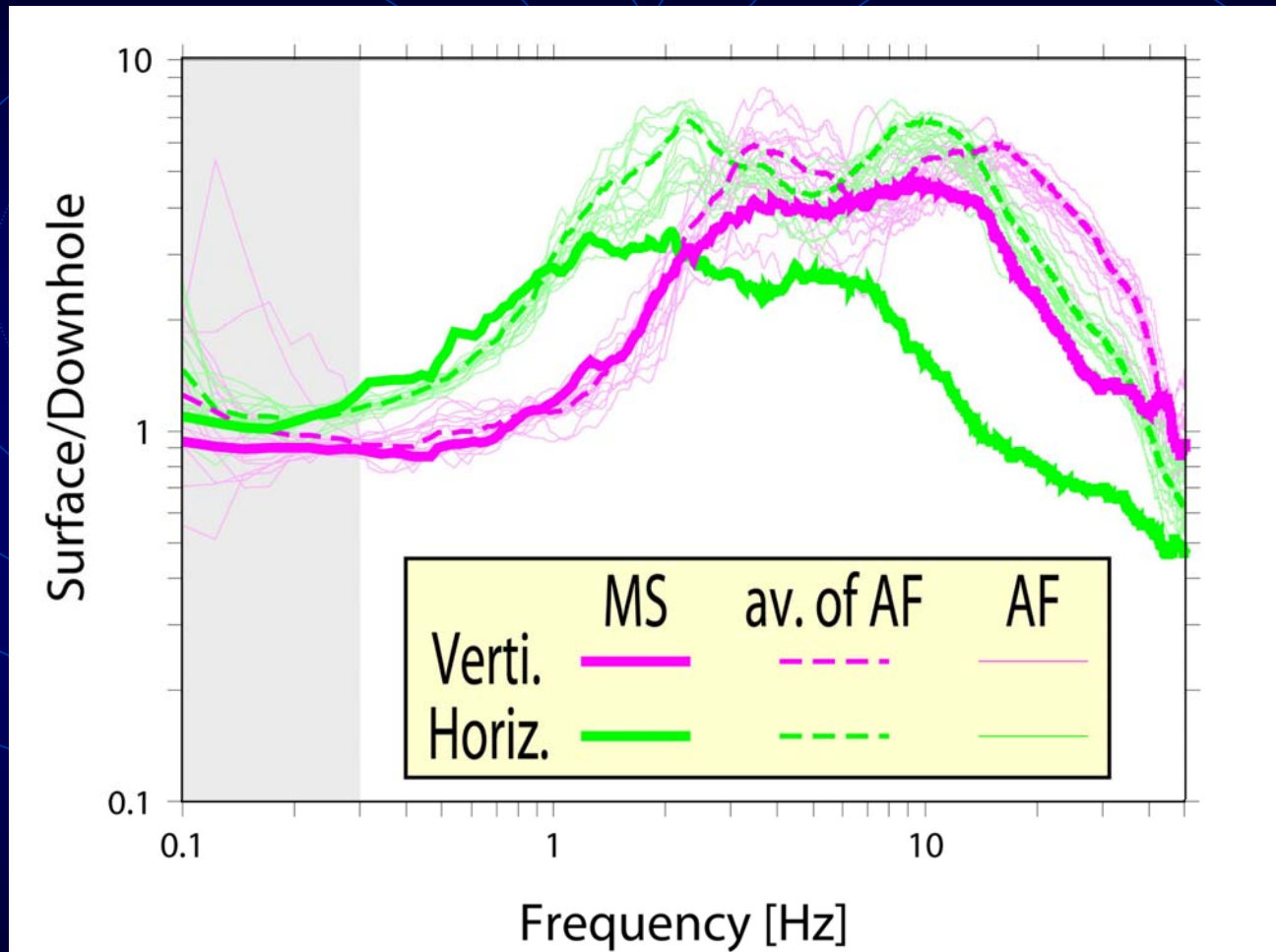
Observed and simulated accelerograms (borehole) at IWTH25



Observed and simulated spectra (borehole) at IWTH25

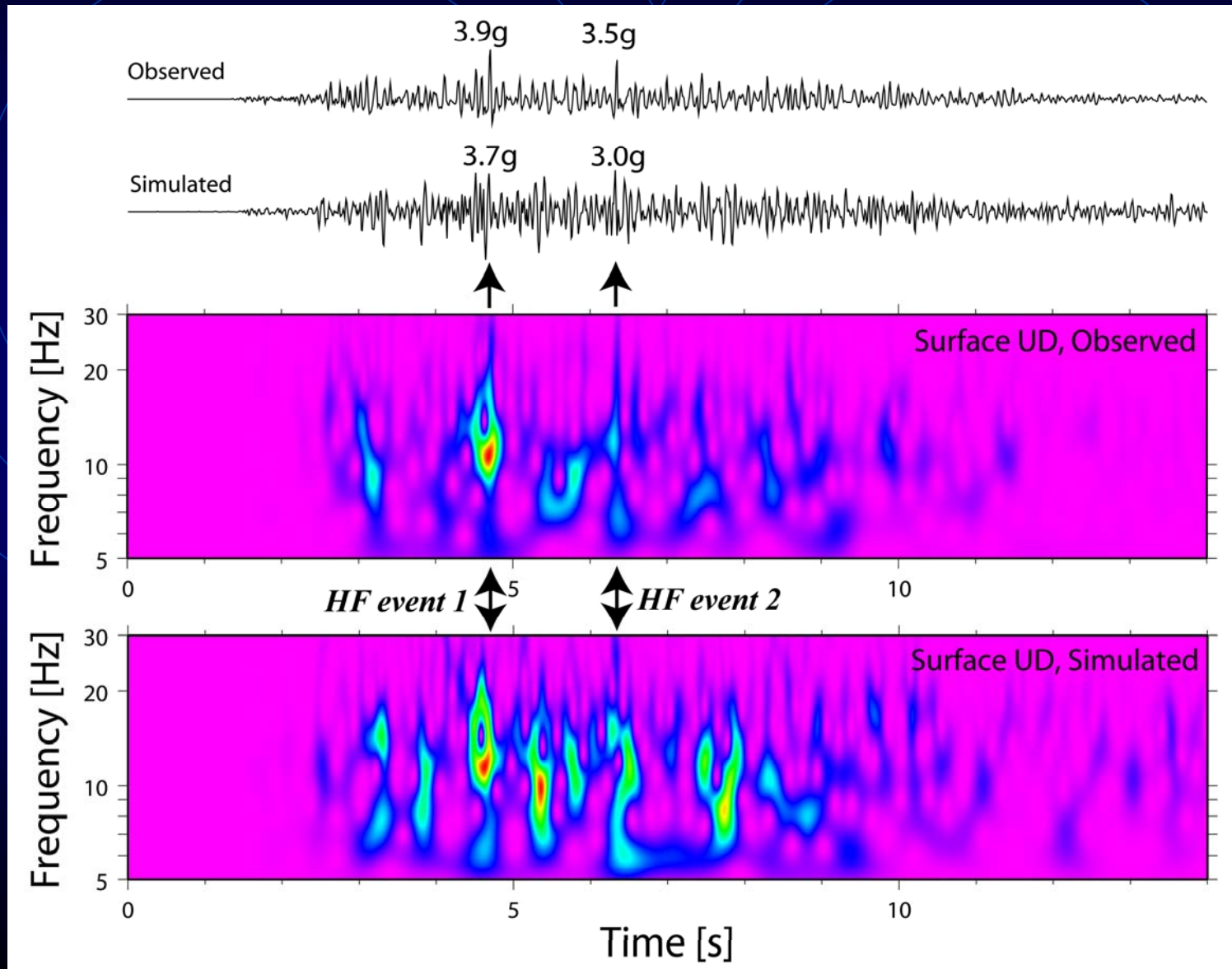


Empirical borehole response at IWTH25 station



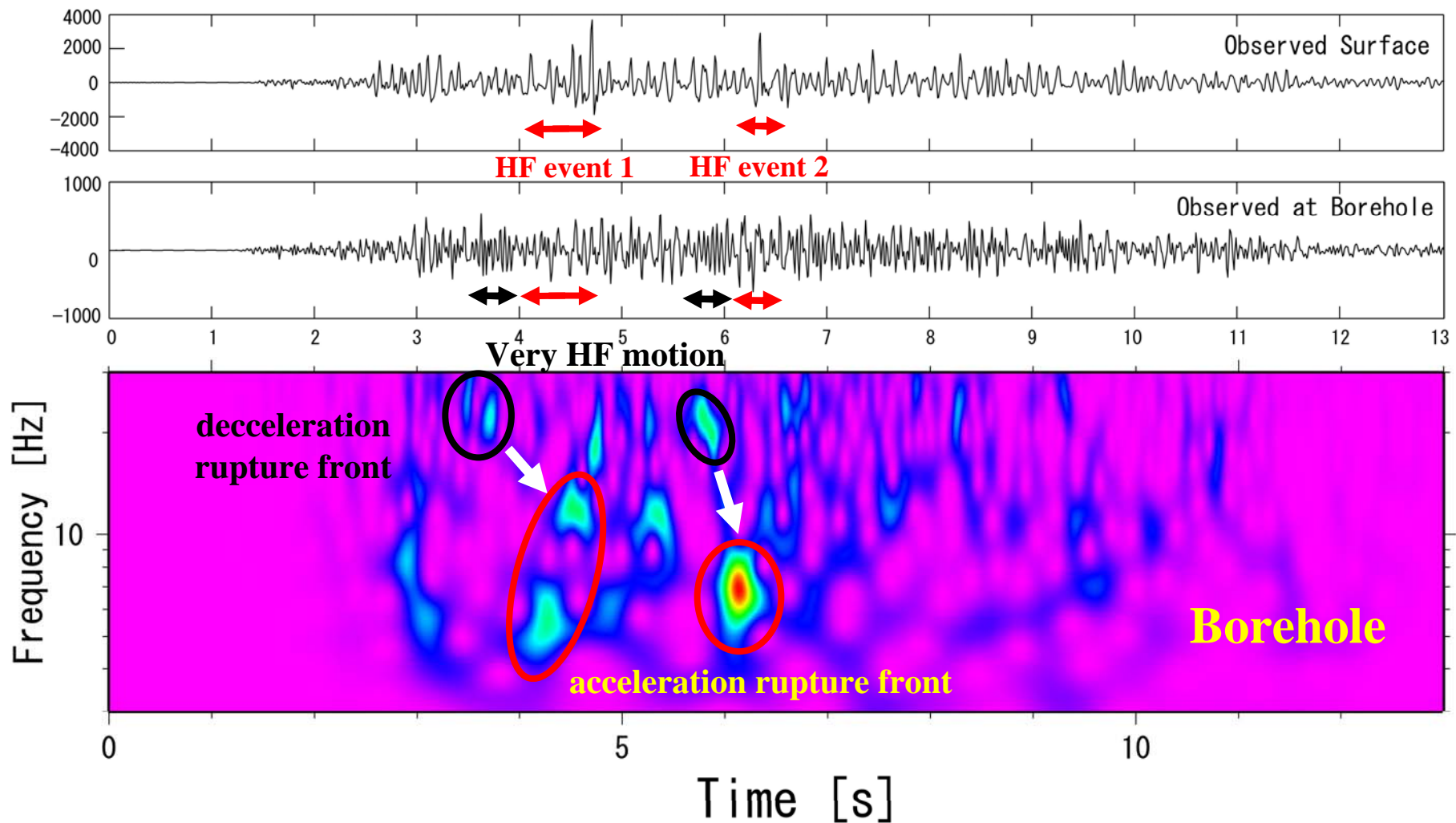
S. Aoi et al. (2008)

Observed and Simulated UD component (surface) at Iwth25 (bandpass filter 5-30Hz)



Rupture front variability and observed UD component (surface and borehole) at IWTH25

(bandpass filter 5-30Hz)



Conclusions

- We simulated the extreme ground accelerations observed at the West Ichinoseki, KiK-net station during the 2008 Iwate-Miyagi Nairiku, Japan, earthquake.
- We identified two HF ground motion events located at 4.5s and 6.3s originating at the source, which derived in the extreme observed accelerations of 3.9g and 3.5g.
- We propose that the extreme accelerations recorded during the Iwate-Miyagi Nairiku earthquake were induced by two strong rupture velocity acceleration events at the rupture front.

Future work

- Construct a dynamic model that is able to reproduce the observed rupture velocity changes and HF events of the Iwate-Miyagi Nairiku earthquake.
- To study the nonlinearity of soil observed in the vertical component of West Ichinoseki KiK-net station, leading to the observed strong asymmetry of ground motion.