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## Long-Period Ground Motion Characteristics and Simulations in the Osaka Basin during the 2011 Great Tohoku Earthquake



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✓ Long period ground motions in Osaka sedimentary basin during the 2011 Tohoku earthquake (Mw9.0) and its largest aftershock (the 2011 Ibaraki-oki eq., Mw7.7) Characteristics of ground motions

### ✓ Long period ground motion simulations

For the 2011 Ibaraki-oki earthquake **✓** For the 2011 Tohoku earthquake

### ✓ Conclusion

Acknowledgements:

We used strong motion data recorded by K-NET, KiK-net and F-net of NIED, CEORKA, BRI, JMA, Osaka city waterworks bureau, and Osaka prefecture. GMS provided by NIED is used for the computation.

Comparison of observed ground velocities (Period range 5-8s) during the 2011 Tohoku mainshock at Shinjyuku (Kanto basin) and Sakishima (Osaka basin).





#### Comparison of ground velocities during the 2011 Tohoku earthquake

# Map of maximum pSv (Pseudo Response Velocity) of horizontal component during the 2011 Tohoku earthquake





Bedrock depth (Japan Integrated Velocity Structure Model (Koketsu et al., 2012)

Osaka bay area	: Tp~7s
Kawachi sub-basin	: Tp~6s
Uemachi Plateau	: Tp~3s

# Map of maximum pSv (Pseudo Response Velocity) of horizontal component during the 2011 Tohoku earthquake





Comparison of observed ground velocities (Period range 5-8s) during the 2011 Tohoku largest aftershock (Ibaraki-oki, Mw7.7) at Shinjyuku (Kanto basin) and Sakishima (Osaka bay area).





- ✓ Long period ground motions at Osaka sedimentary basin during the 2011 Tohoku earthquake and the 2011 Ibarakioki earthquake.
- + The period range of 2 to 10s, the amplitude of horizontal components of the ground motions at the Osaka basin sites show the site-specific predominant period and amplification.
- + The predominant period is about 7s in the Osaka bay area where the largest pSv (5%) was observed.
- + The observed ground motion characteristics from the source area to the Osaka basin sites show the needs of ground motion simulation including not only the Osaka basin but the source and propagation-path effects.
- + Similar characteristics for long period ground motions were observed during the 2011 Ibaraki-oki earthquake.

✓ Long period ground motion simulations

For the 2011 Ibaraki-oki earthquake For the 2011 Tohoku earthquake

+ Firstly, we simulate the long period ground motion simulation during the 2011 Ibaraki-oki earthquake because of the relatively simple source model.

- + The Japan Integrated Velocity Structure Model (JIVSM, Koketsu et al., 2012) is used for the simulation, with a slight modification for the bedrock S-wave velocity in Osaka area.
- + Simulated ground motions (period range 4 10 s) are explained fairly well for the 2011 Ibaraki-oki earthquake. The JIVSM is confirmed by the simulation.
- + Next, we conduct the long period ground motion simulation for the mainshock.

## Long period ground motion simulation for the 2011 Tohoku mainshock

#### >Method

#### 3D FDM(Aoi & Fujiwara, 1999)

#### >3D underground velocity structure model

The JIVSM (Koketsu *et al.*,2012), modified the bedrock S-wave velocity in Osaka area Model space 400km\*730km\*100km (red broken line)

Grid space 200m\*200m\*100m (600m\*600m\*300m) Minimum S-wave velocity 350m/s reliable period longer than 3s

#### >Source model

Two point sources

Position at the centroid points of SMGA3 and SMGA4 (the SMGA model from Asano and Iwata, 2012)

Source time function is the bell-shaped with the duration of 11s. Rake angle is set to 100deg. Moment magnitude for each SMGA is 7.6 and 7.3, respectively.

(SMGA: Strong Motion Generation Area)

#### >Calculation duration

Interval 0.005s, 80000steps Totally 400s



Observation station distribution and the four SMGA source model for the Tohoku event (Asano and Iwata, 2012).







## **Comparisons of pSv ratios between synthetics and observations**



Comparisons of pSv ratios between synthetics and observations at periods of 5 s (left), 7 s (center), and 9 s (right) for the Tohoku earthquake. Blue, yellow, and green dots indicate the stations in the Kanto, the Nobi, and the Osaka basins.



Comparisons of pSv (peak period and level) in the Osaka basin for Tohoku earthquake



Comparisons of azimuthal pSv in the Osaka basin for Tohoku earthquake



N332E component of simulated ground velocity

## ✓ Conclusion

- + Long period ground motions (2-10s) are observed during the 2011 Tohoku earthquake (and the 2011 Ibaraki-oki earthquake) in the Osaka sedimentary basin, more than 500km far from the source area.
- + The period range of 2 to 10 s, the amplitude of horizontal components of the ground motions at the Osaka basin sites show the site-specific predominant period and amplification.
- + Using two-point-source model and the JIVSM, the simulation reproduce fairly well the long-period ground motion characteristics.

## Thank you for your attention

