Comparison of PGA and PGV at the S-net and land stations for the 2016 Mw7 off Fukushima earthquake

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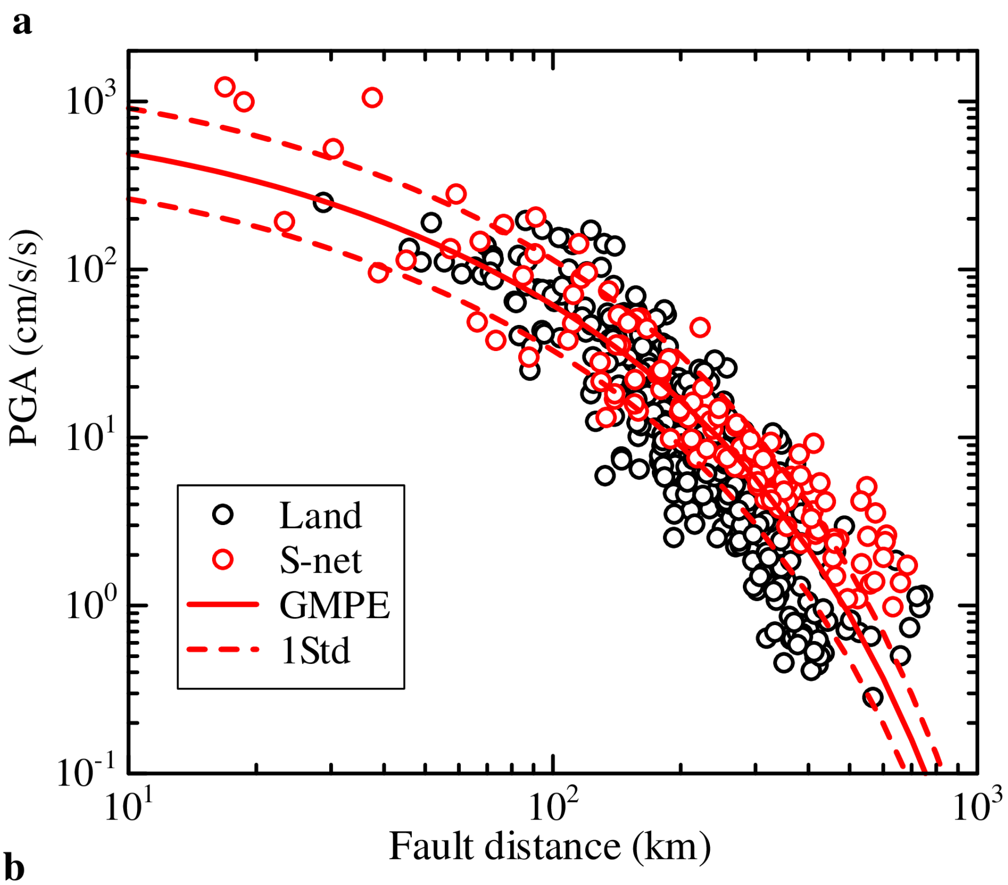
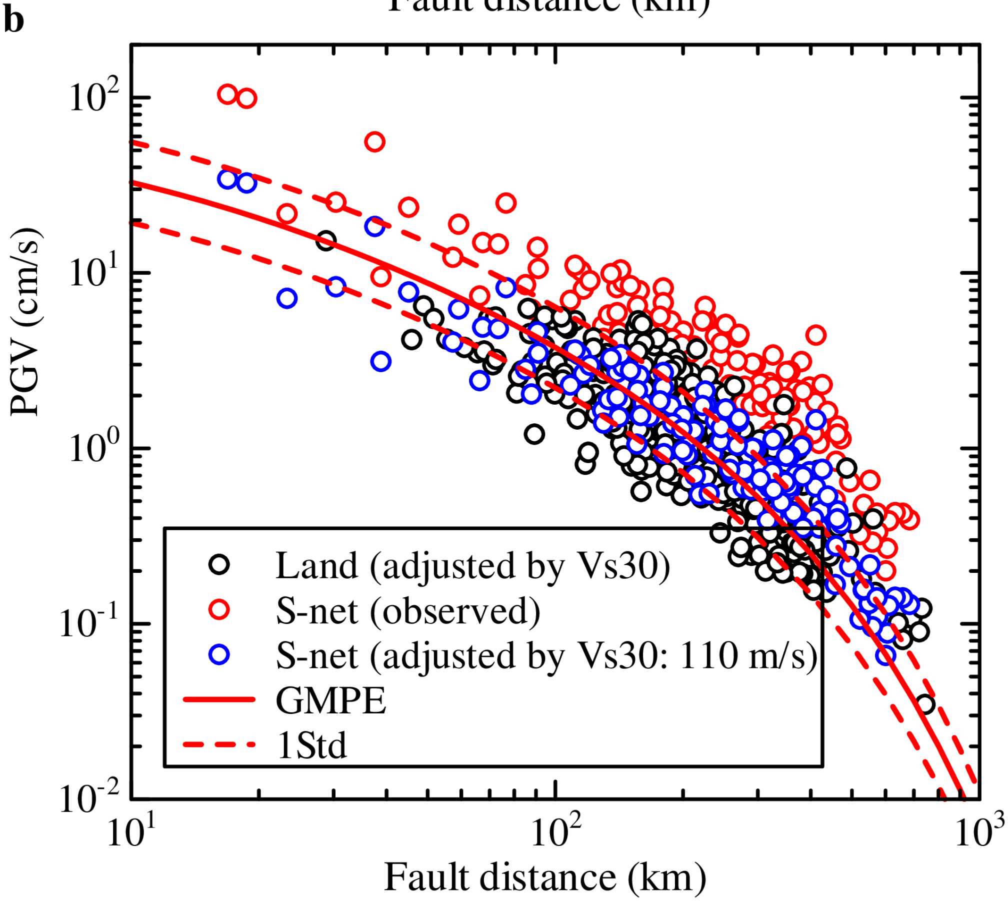
The 2016 Mw 7.0 off Fukushima earthquake was the largest earthquake that occurred in the off Tohoku region after the deployment of the Seafloor observation network for earthquake and tsunami along the Japan Trench (S-net). One hundred and twenty-five stations of five segments of S-net except for the outer rise segment, which was not in operation during the earthquake, successfully recorded the seismic motions during the earthquake. We processed the strong-motion recordings at land (K-NET and KiK-net) and ocean bottom (S-net) stations for comparing peak ground acceleration (PGA) and peak ground velocity (PGV) for the abovementioned earthquake. One main difference between the land and S-net stations is that the sensors at S-net stations can undergo larger coseismic rotations compared to those on the land stations (Takagi et al. 2019, Nakamura and Hayashimoto 2019) for large PGAs. However, it has been found that the X-axis is more stable compared to the other two axes. Therefore, we selected the PGA of X-component for the S-net stations and lager PGA of two horizontal components for land stations for the comparison. We compared the PGA and PGV values with the attenuation curves using the equations in Si and Midorikawa (1999). We computed the fault distance using the model by Kubo et al. (2016). We found that the PGAs at the land (soil site condition) and S-net stations were generally explained well by the attenuation curve with small mean errors at distances smaller than 200 km (Fig. a). On the other hand, the attenuation was faster at the land stations than that at the S-net stations at larger distances. We adjusted the PGVs at the land stations for reference site condition of Vs30 of about 600 m/s following the procedure explained in Si and Midorikawa (1999), and compared the values with the attenuation curve. Again, we found that the PGVs on land were generally explained well by the attenuation curve within the expected error margins. On the other hand, the observed values at the S-net stations were larger by a factor of about three at distances < 200 km and by a factor of about four at distances > 200 km on average (Fig. b). Due to the lack of S-wave velocity information at the S-net sites, by using trial and error approach, we found that the Vs30 value of about 100-125 m/s, assumed identical at all sites (the simplest case), was needed to produce the mean error similar to that at land stations at distances within 200 km. A comparison of the PGVs after adjustment for the Vs30 value of 110 m/s is shown in Fig. b. The low Vs30 value used in the correction generally corresponds to the Vs30 values at some of the KiK-net stations, such as at Atsuma, Edosaki, Aso, and so on. However, the observations were larger than the mean predictions by a factor of about 1.5 on average at distances > 200 km even after the correction by the Vs30 value. It requires further examination to explain the difference at larger distances, such as the effect of sediment thickness and propagation path effect. We have been analyzing the data for a suite of earthquakes in the region, and report the results in the future papers.

Keywords: S-net, Attenuation, Ground motion prediction equation, Vs30, K-NET, KiK-net


a
PGA (cm/s/s)
Fault distance (km)
Land
S-net
GMPE
1Std


b
PGV (cm/s)
Fault distance (km)
Land (adjusted by Vs30)
S-net (observed)
S-net (adjusted by Vs30: 110 m/s)
GMPE
1Std