# Basic study for developing the Earthquake Early Warning system for large crustal earthquakes-

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## 1. Introduction

The Earthquake Early Warning (EEW) system in Japan provides the source information such as the hypocenter, origin time and magnitude about four seconds after earthquake occurrence. The shaking information at target sites is calculated based on the empirical attenuation-distance relationship of PGA from the magnitude, hypocentral distance and site amplification. For a large earthquake an idea of source radius is taken into account for applying the attenuation-distance relationship, because the point source assumption is not available.

However, to apply the EEW to large earthquakes more than magnitude 6.5 there are some problems to solve. In most of cases, smaller magnitude of the earthquake is obtained using a short duration data of the onset of its seismograms and then ground motions might be underestimated. In this study, we try to obtain it from observed records of large crustal earthquakes using the attenuation relations of acceleration and velocity records in near-source areas.

## 2. Attenuation relations in near-source areas for ground motions from large crustal earthquakes

Peak ground acceleration (PGA) of P-waves and S-waves and peak ground velocity (PGV) of S-waves with shortest distances from rupture area to sites are shown in Figure.1 for the 2004 Chuetsu earthquake (Mw6.6) and the 2008 Iwate-Miyagi Nairiku earthquake (Mw6.9). The PGA of the P waves and are taken from the maximum motions of vertical components of the P waves' parts. The PGA and PGV of the S waves are those of horizontal motions of the S waves' part. The PGA's of P-waves as well as those of S-waves from both earthquakes seem to be saturated within the distance of about 20 km to the rupture area. Such phenomena are consistent with the attenuation relations of maximum acceleration of S-waves in the NGA reports in US (e.g. Abrahamson and Silver, 2008).

The horizontal ranges of the above saturation relate to the extension of the rupture of large earthquakes as already known. Therefore, if the saturation level of the PGA of the P waves is known in advance, we can provide the information about the rupture extension before the arrival of the

S-waves. We find the PGV also is saturated as well as the PGA at station close to rupture area. The PGA and PGV close to rupture area in the Iwate-Miyagi Nairiku earthquake are almost the same as those in the Chuetsu earthquake. Further, we need to study magnitude dependence of the saturation levels collecting observed records from other large earthquakes with different magnitudes.

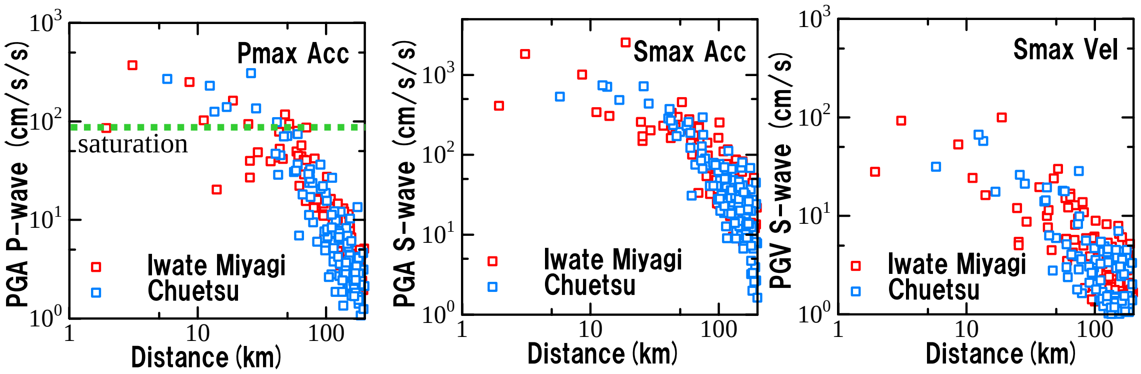


Figure 1. Attenuation-distance relationships of PGA of P waves, PGA of S waves and PGV of S waves for the 2008 Iwate-Miyagi Nairiku earthquake.

We also find that the PGA's of P waves well correlate with the seismic intensity in distances where the PGA's of P waves are not saturated.

## 3. Conclusion

The PGA of P-waves and S-waves are saturated in the attenuation-distance relations near the rupture areas. If we combine the information about the hypocenter with the P wave saturation area, it is possible to estimate the maximum ground motions of the S waves for real-time risk assessment. Further study should be required to obtain the absolute saturation levels dependent on magnitude removing local site effects due to near surface geology from observed data.