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An application of site response functions to ground motion prediction

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The prediction of ground motion from large future earthquakes is very important for hazard mitigation in urban areas of Japan. Because the observed ground motions are affected by three factors; the seismic source, attenuation (quality factor) of seismic wave propagation inside the earth, and the effects of the local surface geology, understanding each factor is essential for the ground motion prediction. The recorded ground motions from almost all recent large events have reinforced the role of site effects in the level of strong shaking. Because most large cities in Japan are located on thick sedimentary basins, accounting for site response is essential for realistic predictions of ground motion. The analysis of well-recorded data from dense seismograph arrays can reduce the uncertainties in our ability to predict future ground motions that are related to our understanding of the affects of source, path, and site conditions. The new technique presented in this study provides a site response correlation function for estimation of the spatial distribution of site response. This function is based on the known site responses at instrumented sites and is used to estimate the site response at a site for which there is no instrumental records. We initially predict the level of ground motion by using this estimate with the assumption of linear wave propagation. This method is applied to the data from a relatively dense seismic array located near the city of Sendai, Japan by using moderate sized earthquakes with small ground motion levels to estimate linear site response. We show the comparisons of simulations using this method with observations from large events; 2003(Mw7.0), 2005(Mw7.2), and 1978 (Mw 7.5) Miyagi-Oki earthquakes. Broadband ground motion using a hybrid finite difference (low freq.) and f-k (high freq.) technique to compute motions at seismological basement (Vs=3 [km/sec]) are convolved with the linear site response based on the data from the moderate sized events. Because the 1978 event did not have records at sites in common with the current dense array in Sendai, predicting ground motion for 1978 event is a good blind test for our method. The agreement of the predicted spectrum amplitude with the observed indicates the applicability of our method to simulate past as well as future ground motions.