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Asperity model of the intra-slab earthquake and scaling law of the source parameters

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Strong motion observation network made rapid progress in Japan for source modeling and understanding the relation between heterogeneous source process and generation of strong motion (e.g. 1997 Kagoshima-ken Hokuseibu earthquake, 2000 Tottori-ken Seibu earthquake). The source characteristics of the intra-slab earthquake, which occurs rarely compared with these crustal ones, have been examined for great earthquakes, but moderate-size intra-slab earthquake were scarcely examined (Yamauchi and Kakehi,2001). It's pointed out that the ground motion characteristics from intra-slab earthquakes are different from those of the crustal ones. To find the source characteristics of intra-slab earthquakes are a quite important issue for source modeling and strong ground motion simulation.

We tried to estimate asperity or strong motion generation area using strong motion records to examine about the scaling law of the source parameters of some moderate or large intra-slab earthquakes occurred after the strong motion observation network were installed.

We used the empirical Green's function method (Irikura,1986) for ground motion modeling to estimate number, size, location of asperities, rise-time, and rupture velocity by forward modeling (Miyake et al.,1999). In this study, we examined the source model of 3 intra-slab earthquakes, the 1997 Aichi-ken Tobu earthquake (Mj5.8), the 2001 Geiyo earthquake (Mj6.7), and the 2001 Shizuoka-ken Chubu earthquake (Mj5.1). These occurred at the 30 - 50 km depth near the surface of the Philippine Sea slab subducting under the Eurasia plate. We selected one fault plane referring to the CMT solution by Freesia project to have a better fitting. We used more than 4 stations that distribute around the source, and simulated horizontal acceleration, velocity, and displacement in broadband frequency range (e.g. 0.2-10Hz for the Geiyo earthquake).

The number of asperity is estimated as one about the Aichi-ken Tobu earthquake and the Shizuoka-ken Chubu earthquake, and the asperity size for the Aichi-ken Tobu earthquake is 2.7km**2 and for the Shizuoka-ken Chubu earthquake is 2.9km**2, respectively. The fitting is fairly good in waveform and duration time. As for the Shizuoka-ken Chubu earthquake, the fittings of the displacement at some components in some stations near the node of focal mechanism are not good. This was mainly caused by delicate difference of focal mechanism between the mainshock and the aftershock and ambiguity of focal mechanism itself.

For the Geiyo earthquake, it's pointed out that the source has two asperities from the waveform inversion result [e.g. Sekiguchi and Iwata(2001)]. We also used two asperity model that fairly well reproduced observed ground motions. The combined area of asperities are estimated about 55km**2. The position of asperities approximately corresponds to the area of the large slip by the waveform inversion. The rupture velocity for each event is estimated about 70 - 80 % of the S-wave velocity near the focal depth.

We compared the combined area of asperities obtained from this simulation with those for crustal earthquakes using the crack model [e.g. Miyake et al.(2001)]. The relation between the combined area of asperities and the seismic moment follow the empirical relation for crustal earthquakes by slip characterization of the waveform inversion results compiled by Somerville et al.(1999), but the combined area of asperities for intra-slab earthquakes are just 25-70% of the size guessed from the relation. This result sustains the existing hypothesis that an intra-slab earthquake has relatively large stress drop compared with a crustal one. But stress drop values itself scatter between events, and we need to analyze more event with the same procedure for making clear the reason of scatters.

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