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# 三次元走時表を用いた不均質速度構造における震源決定
# Hypocenter location in an inhomogeneous velocity structure with three-dimensional traveltime table

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An inhomogeneous velocity structure has considerable effect on the accuracy of the earthquake locations in complicated tectonic setting areas like the Japanese Islands. Calculation time is still one of the problems for hypocenter location in a three-dimensional velocity structure. We show a evaluation of calculation time of event location in a three-dimensionally (3D) inhomogeneous velocity structure with lookup tables for each seismic station on the Japanese Islands.

We made 3D traveltime tables for each station to reflect the 3D velocity structure in the event location. The traveltime tables were prepared beforehand for each station. Traveltimes for a station were calculated at grid points of three-dimensional coordinate with a ray-tracing method by Um and Thurber (1987). Traveltimes were calculated for blocks of (1 deg.)X(1 deg.)X(50km) where events had been detected. The grid interval in the block was set depending on distance from the station. The number of stations and blocks are 1,813 and about 250 thousand, and it took about one month of elapsed time on a 128-core cluster machine.

Hypocenter calculation times of 11,448 event locations in January, 2014 were compared for 1D traveltime table (1D-TT), 3D traveltime table (3D-TT), and 3D ray-tracing method (3D-RT). Arrival times in the unified seismic catalogue in Japan were used. The calculation time of one event was within one second for 1D-TT and 3D-TT with an ordinary workstation. The maximum calculation time for 3D-TT was quick enough to be used in interactive processing. On the other hand, some of the calculation time of 3D-RT were more than 10,000 seconds. The time of the 3D-TT was about 1,800 times shorter than that of 3D-RT as an average of logarithmic calculation times. The difference between 1D-TT and 3D-TT is four times as an average of logarithmic calculation times.

An interpolated traveltime is different from that calculated with ray-tracing method at the grid point of the blocks in our method. The difference was checked at every grid point in the blocks. The maximum differences of 82% blocks were less than 0.1 second. However, those of 0.01% of blocks exceeded one second. The large difference was usually caused by stepwise traveltime variation due to ray-path scattering.

Hypocenter locations were compared among ray-tracing, three-dimensional traveltime table, and one-dimensional traveltime table. Whereas the locations of 3D-TT of 98.3% events were close to that of 3D-RT than that of 1D-TT, 3D-TT locations were very close to those of 1D-TT for some events. Many of those events are offshore events or inland events with small differences. It is considered that the location difference were partly caused by the unstable condition in hypocenter location.

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