Improvement of the DSM computational efficiency to calculate partial derivatives of synthetic spectra w.r.t 3-D earth structure

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Hara and Geller (2000) showed that the improvement of the computational efficiency of the Direct Solution Method to calculate partial derivatives of synthetic spectra with respect to model parameters of 3-D earth structure becomes slower as the number of processing elements (PEs) increases. In the present study, we rearrange the order of the model parameters so that the total number of non-zero matrix elements assigned to each PE is roughly equal. Preliminary calculation for 64 model parameters show that the value of (elapsed time for 1 PE)/(elapsed time for 8 PE) is 6.7 before rearrangement while that becomes 7.1 after rearrangement. This suggests that rearrangement of the order of model parameters can improve the computational efficiency significantly.

Hara and Geller (2000) and Hara (2000) implemented the codes of the Direct Solution Method (DSM. Hara et al., 1991) on vector-parallel supercomputer, and showed that it was possible to greatly improve the DSM computational efficiency by parallel computation. The computation required for performing waveform inversion for 3-D earth structure using the DSM consists of three parts: (i) solving equation of motion in the frequency domain, (ii) calculating partial derivatives of synthetic spectra with respect to model parameters of 3-D earth structure, and (iii) inverse FFT to compute synthetic seismograms. Hara and Geller (2000) showed that the improvement of computational efficiency for the parts (i) and (iii) is almost proportional to the number of processing elements (PEs) which varied in the range of 1-8 in their experiments. They also showed that the improvement for the part (ii) becomes slower as the number of PEs increases. This may be due to the difference of total numbers of non-zero matrix elements assigned to each PE. In the present study, in order to improve the computational efficiency for the part (ii), we rearrange the order of the model parameters so that the total number of non-zero matrix elements assigned to each PE is roughly equal. We perform preliminary calculation for 64 model parameters using NEX SX-4/8 at the Geographical Survey Institute, which has 8PEs. The value of (elapsed time for 1 PE)/(elapsed time for 8 PE) is 6.7 before rearrangement while that becomes 7.1 after rearrangement. This suggests that rearrangement of the order of model parameters can improve the computational efficiency significantly.