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A New Procedure of Seismic Ray Tracing for Hypocenter Location Using a 3-D Global Velocity Structure

TOMOYA HARADA

Graduate School of Science and Technology, Kobe University

In current hypocenter determination procedures, 1-D radial earth models are usually used to calculate travel times and lateral heterogeneities are compensated by station corrections. However, many studies of seismic tomography have revealed relatively detailed velocity structures in the earth, which can be now used for hypocenter location. Hypocenter determinations for 3-D structures need to calculate travel times by 3-D ray tracing method. I have developed a new procedure of ray tracing for this purpose. It has been modified from the 3-D ray tracing technique developed by Koketsu and Sekine (1998), which uses the pseudobending method. The new procedure can calculate travel times of reflected and refracted rays for 3-D heterogeneous earth models. Concretely, (1) It examines every time whether a ray bent by the pseudo-bending method newly intersects with a deeper discontinuity or not; (2) It can calculate travel times of head waves such as Pn at short epicentral distances by giving initial rays adequately; (3) It applies Snell's low in curvilinear coordinates used by Koketsu and Sekine (1998) to calculate bounce points of reflected rays. In order to check the accuracy of the new 3-D ray tracing procedure, I made simple numerical tests. I put imaginary hypocenters at depths of 0, 50, 100, 150, 200, 250, 300 km, and 900 imaginary stations on the earth's surface at an interval of 0.1 degree for the epicentral distance range of 0-90 degrees. I calculated travel-times of P, S, PP, SS, pP, sS, PcP, and ScS by the new procedure for the iasp91 radial earth model (Kennett and Engdahl, 1991), and compared calculated travel times with the iasp91 travel-time table. The results have been satisfactory, and the accuracy of the procedure is considered enough to be used for hypocenter determination. However, it is further required to reduce calculation cost and to improve the accuracy of travel time calculation of reflected rays at short distances for deep sources. I thank Professor Koketsu for providing me with his 3-D ray tracing computer program.

Keywords: global velocity structure, 3-D, hypocenter determination, ray tracing, pseudo-bending method, refracted wave, reflected wave, numerical experiment

References

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