Focal Mechanism Determination Using 3-D Velocity Structure

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Various agencies routinely determine focal mechanism solutions by layered (one dimensional) velocity structures. However, when the assumed structures are much different from real ones, we inadequately evaluate azimuths and take off angles. Moreover, when assumed hypocenters (especially depths) are much different from real ones, we cannot adequately determine focal mechanisms. In this study, we determined focal mechanisms by using the three dimensional (3-D) velocity structure beneath Japan obtained in Nakamura et al. (2003) and hypocenter parameters determined by Nakamura (2004).

The velocity structure was obtained by applying the seismic tomography method proposed by Zhao et al. (1994). The grid interval was about 10km in the shallow areas of main 4 lands, and was about 30km in other areas. For the inversion, they explicitly defined the Conrad, the Moho and the upper boundary of the Pacific plate. To determine focal mechanisms, we used a grid search method described in Nakamura (2002). Moreover, we evaluated azimuths and take off angles by the ray tracing method used in Zhao et al. (1994), which is hybrid one of Snell's law and pseudo bending (Um and Thurber, 1987).

We applied the method to 421 events occurred in 2002, whose focal mechanisms were determined with acceptable reliability by Japan Meteorological Agency. Most of take off rays and axes of mechanism solutions shift about 10 degrees in the center angle. When we simply compare calculated solutions and JMA's ones, there are some cases where solutions are much different each other. In those cases, reliabilities of those solutions are not so good. It is valuable to evaluate focal mechanisms by using the 3-D velocity structure, only when the reliability of the target solution is high, specifically acceptable areas of solution axes are less than 10 degrees in the center angle.

References: Nakamura, 2002, PEPI, 130, 17-29.; Nakamura et al., 2003, Abstr. 2003 Japan Earth Planet. Sci. Joint Meeting, S053-P010.; Nakamura, 2004, Abstr. 2004 Japan Earth Planet. Sci. Joint Meeting. ;Um and Thurber, 1987, BSSA, 77, 972-986.; Zhao et al., 1994, JGR, 99, 22313-22329.