Development of hypocenter determination method for reducing modeling error term with dense observation network

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The simplified velocity structure model to calculate the theoretical travel time is used in the hypocenter determination, which is always different from real velocity structure. Due to development of seismic observation network and improvement of data quality, modeling error becomes relatively increasing in the hypocenter determination. To migrate the effect of the modeling error terms, we developed the hypocenter determination method with dense observation network.

In this study, we determined hypocenter coordinates using difference of observation equation in two observations for reducing the modeling error term, and examined the validity of new formulation through a synthetic test.

We assumed hypocenter located center of artificial observation network, and we calculated synthetic travel time with the velocity structure, assumed the difference in east and west in the hypocenter. To estimate hypocenter location, we assumed uniform structure model.

In this synthetic test, we obtain the estimation error that is the difference between given and estimated hypocenter location. The estimation error with traditional formulation was 3˜5 km, while that with our formulation was 1˜3.5 km. In horizontal components, the estimation error was decreased especially with our formulation. Next, we determined hypocenter with only combination of observations in the same group under assumption that geological structure was known. In this case, the estimation error was less than 2 km, and the horizontal error was less than 1 km. Next, we determined hypocenter with robust estimation to except combinations having large error difference. In this case, the estimation error was 0.5˜2.5 km, and a little larger than that of grouping case. From the above result, it was clarified that using our formulation could reduce the bias effect due to the structure modeling.