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Hypocenter relocation in Hokkaido Region with Three-dimensional velocity structure

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Introduction

We, Japan Meteorological Agency, routinely determine hypocenter location using data from our seismic network and networks maintained by other organizations. Because we use one-dimensional velocity structure(JMA2001, Ueno et al. 2002) to locate earthquakes, there are problems in location accuracy caused by velocity anomalies not represented in JMA2001. For Hokkaido region, the problems are obvious in northern and eastern Hokkaido, where large lateral heterogeneity exists. Hypocentral depth is often determined at just 0km there. So we plan to conduct (1) travel-time tomography to reveal three-dimensional velocity structure in Hokkaido region and (2) earthquake relocation using the obtained structure. According to preliminary results around 2004 Rumoi-nanbu earthquake (M6.1) focal area, we obtained better hypocenters compared with JMA unified earthquake catalog.

Data and Methods

Tomography program developed by Katsumata(2010) is used in this study. In this program, velocity structure is represented by three-dimensional nodes with spline interpolation. This program can include discontinuous layer, and can invert velocity structure and shape of discontinuous layer simultaneously.
We use travel-time data based on the unified catalog for tomography. Then, we select clear phase arrivals, and select earthquakes to be distributed uniformly at target region.
To relocate earthquakes around Rumoi-nanbu earthquake focal area, we conducted seismic tomography to determine three-dimensional velocity structure about 100km around the focal area. We selected 5753 rays from 714 earthquakes which occurred at depths shallower than 30km. Initial velocity structure was almost same as JMA2001. Nodes representing velocity structure were put every 0.1 degree in horizontal direction, 5km in vertical direction. We did not include discontinuities.

Characteristics of velocity structure and relocated hypocenters

Based on checker-board test, we got good resolution from 0km to 15km in depth. S-wave velocity structure shallower than 10km at western side of Hokkaido mainland are imaged as low-velocity region, which is consistent from other results (e.g. Nishida et al., 2008). P-wave velocity structure near the subsurface is imaged to be mainly low-velocity, so this result indicates presence of sedimentary layer (e.g. Tamura et al., 2003). At 10km depth, we find low- and high- velocity region stood alternately among mainland and Teuri/Yagishiri islands. This structure would be related to strain accumulation zones.
Relocated hypocenters of Rumoi-nanbu earthquake focal area show much clear dipping eastward than the unified catalogue. The number of hypocenters determined at 0km depth is decreased in our results. Compared with relocated hypocenters using temporal stations (Ichiyanagi et al., 200 7), our results are similar to their results than the catalogue. Hypocenter location is improved especially in vertical direction, however, there are no clear differences in horizontal direction

between our result and the catalogue. This fact indicates limitations due to using only permanent stations to estimate velocity structure and to locate earthquakes.

Conclusion

Preliminary results around 2004 Rumoi-nanbu earthquake focal area shows that there are improvements in hypocenter locations compared with the unified catalogue. We are working on (1) estimation of three-dimensional velocity structure and (2) relocation of earthquakes in the crust in Hokkaido region.

Acknowledgements

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References

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