Techniques of using data from OBS stations for EEW

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Introduction

JMA EEW information are compiled from data of small numbers of stations, to estimate hypocenter quickly for immediate release to the public. In Japan, large earthquakes occur in the surrounding ocean area. Thus, using ocean bottom seismometers (OBSs) for EEW would be quite effective, and we should know thoroughly about the response of our estimating methods when using OBS data.

Current methods used in JMA EEW

· the B−Delta method

The B-Delta method is a step of estimating epicentral distance from a single seismic record in a short period, regardless of magnitude of earthquakes (Odaka, *et al.*, 2003). The brief procedure of this method is as follows:

1. Calculate the absolute value of an accelerogram waveform and fit it to a function $Bt\cdot\exp(-At)$ to determine unknown parameters A and B.
2. Estimate epicentral distance from the empirical relation using parameter B.

· the Territory method

In contrast with the B-Delta method, the Territory method requires a network of seismometers. First, Voronoi tessellation is applied to the earth surface with seismic stations in advance. When an earthquake occurs, a divided area which includes the first detected station is the region that the hypocenter should exist in.

Applying the B-Delta method to OBS data

The first issue is that the parameter used in current JMA EEW is estimated by the seismograms observed at inland stations. So, we confirmed whether the B-Delta relation is also applicable to OBS data.

We used 183 100Hz-sampled accelerograms from 8 OBSs in 3 regions (off Kushiro, off Sanriku, and off Muroto). Number of Earthquakes selected is 81, its magnitude ranging from 5.0 to 8.0. Arrival time of P phase was picked by hand, and waveform fitting to the function was performed using the least square method. From the result shown in figure 1, the relation seems to be rational, though the dispersion is much larger than that of the inland B-Delta relation.

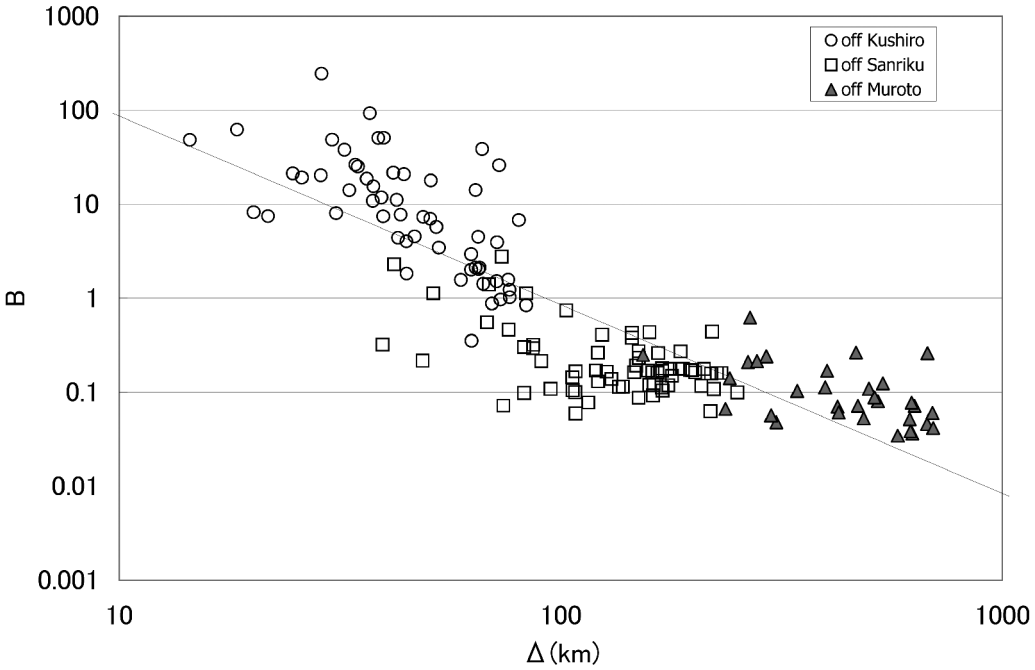

Figure 1: Relation between the parameter B from OBS data and epicentral distance

Open circles, open squares, and closed triangles show each case from off Kushiro, off Sanriku, and off Muroto region, respectively. The oblique solid line denotes the formula to obtain epicentral distance from given B, that have been utilized in JMA for EEW currently.

introducing Additively Weighted Voronoi Tessellation

Second issue is, the Territory method assumes that data transmission delay of all stations are the same. This limitation is derived from that the arrival order is the key concept of this method. Since set up environment of OBS stations are significantly different from that of inland stations, OBS stations may have different transmission delay. In addition, traveltime correction of sedimentary layers may be considarably large. To solve this problem, we introduced the Additively Weighted Voronoi Tessellation instead of the ordinary Voronoi Tessellation.

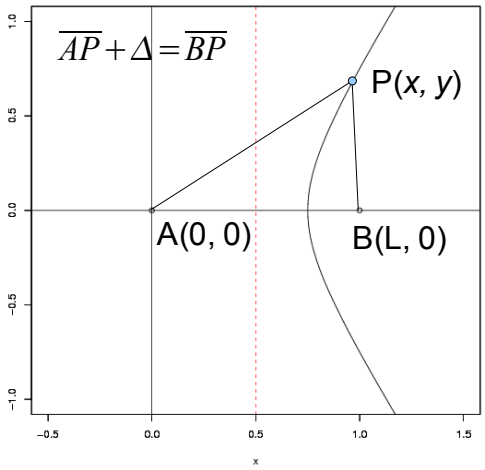

Figure 2: Additively Weighted Voronoi Tesselation between station A and B

Assume that station B has δ (s) delay to station A (we use $\Delta = V_p \cdot \delta$ (km) hereafter), the territory border P should be expressed as $\bar{\mathrm{A}}\mathrm{P}+\Delta=\bar{\mathrm{B}}\mathrm{P}$ (figure 2).

This equation resolves to $f(x,y)=2\mathrm{x}-L-\Delta\sqrt{1+\frac{4\mathrm{y}^2}{L^2-\Delta^2}}=0$, where L is the distance between station A and B. The sign of this function $f(x,y)$ denotes whether a point (x, y) is inner or outer of the territory.

Conclusion

- The B-Delta method is applicable to the OBS data as well as to the inland station data.
- Introducing Additively Weighted Voronoi Tessellation, we can handle different transmission delay of data from each station.

Acknowledgments

We used strong-motion data of JAMSTEC OBS at off Kushiro and off Muroto, ERI OBS at off Sanriku. We thank them for providing valuable data.

Reference

Odaka, *et al.*, A new method of quickly estimating epicenter distance and magnitude from a single seismic record, Bull. Soc. Seis. Am., 93, 2003.