A trial of bias estimation of acoustic transducer position for seafloor geodetic observation

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We have been developing a system for precise seafloor geodetic observation with the GPS/Acoustic combination technique and deploying reference points on the land-ward slope of the major trenches around Japan, such as Japan Trench and Nankai Trough. At each point, we carry out campaign observations with several days each using a survey vessel. In this presentation, we discuss a method to improve the accuracy of position estimation of seafloor reference points by simultaneous estimation biases of acoustic transducer position on the survey vessel.

1. Error factors in positioning the acoustic transducer

For seafloor geodetic observation of Japan Coast Guard, we equip survey vessels 'Meiyo' and 'Kaiyo' with an on-board unit with a GPS antenna and an undersea acoustic transducer installed on the rigid observation pole of about 8m in length, to which it is also attached a dynamic motion sensor. Relative position of th transducer to the GPS antenna is measured in the coordinate system fixed to the vessel(forward-backward, starboard-portside and up-down), and is converted into geographic coordinate system (NS, EW, UD) using roll, pitch and heading values measured by the motion sensor. Adding it to the GPS antenna position, the geographic position of the transducer is determined. Therefore measurement error of the relative position and inconsistency of axes between coordinate system and measurement of motion sensor cause positioning error of the transducer, which deteriorates the positioning accuracy of seafloor reference points.

2. Simultaneous estimation of the bias of acoustic transducer installation and positions of seafloor reference points

Among results of JCG's intensive observation off Miyagi Prefecture, some cases were found that are presumably biased due to the bias of acoustic transducer position. We then tried estimation of the bias.

In our usual analysis for determination of seafloor station position, we apply a theory of Bayesian least squares inversion. From the successive positions of the transducer and the corresponding round-trip travel times of the acoustic waves, we estimate the position of the seafloor stations based on geometrical principles, taking into account the acoustic velocity structure. In this trial, we adopted the bias of acoustic transducer as additional model parameters and simultaneously estimated them with station positions.

3. Results

As a result of data analyses of JCG's intensive observation off Miyagi Prefecture, we detected the bias of forward ˜10cm in all campaigns. Applying this method, the time series of the estimated station positions is less scattered and the rms of traveltime residuals were reduced 1.5-11.8%. This method took effect to improve the accuracy of position estimation of seafloor reference points.

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