# Evaluation of analysis method for GPS/Acoustic seafloor geodetic observation

# Shingo Sugimoto[1]; Keiichi Tadokoro[2]; Ryoya Ikuta[3]; Takashi OKUDA[4]; Yoshitaka Aizawa[5]; Tsuyoshi Watanabe[2]; Jin Yasuda[6]; Daisuke Muto[7]; Keizo Sayanagi[8]; Toshiyasu Nagao[9]; Masataka Ando[10]

[1] Grad. Sch. Env. Studies, Nagoya Univ.; [2] RCSVDM, Nagoya Univ.; [3] ERI. Univ. Tokyo / JSPS; [4] RCSVDM Center.Nagoya Univ; [5] none; [6] Earth and Environmental,Nagoya University; [7] Earth and Environment, Nagoya Univ.; [8] IORD, Tokai Univ; [9] Earthquake Prediction Res. Center, Tokai Univ.; [10] RCSV, Science, Nagoya Univ.

Introduction

Observations of seafloor crustal deformation is very important to understand the dynamics of plate boundary that include the strain accumulation processes, great interplate earthquakes mechanisms, and submarine volcanoes activities. We have been developing an observation system with the GPS/Acoustic combination technique for monitoring of seafloor crustal deformation at the Suruga trough from 2002 [Tadokoro et al., 2003]. Repeated measurements of seafloor transponder can reveal directly the seafloor crustal deformation in the focal area of the subduction zone. The primary purpose of our observation is to detect and monitor the crustal deformation caused by the subduction where huge earthquakes repeatedly occur.

Signification of GPS/Acoustic seafloor positioning

Suruga trough is a stable tectonic area with convergence rate of 2-4 cm/year [Heki and Miyazaki, 2001]. Aside from this, we consider Suruga trough as an appropriate site to evaluate the seafloor positioning because we can set the reference GPS station with short baseline (less than 20 km). The error of the horizontal component of kinematic GPS positioning given such distance is about 1-2 cm. For these reasons, we can evaluate the positioning analysis with high accuracy and the repeatability.

By reduction of the noise due to the vibration of vessel and improvement of installation of the instruments, we could obtain good quality observed data from the middle of 2005 at Suruga trough. Form June 2005 to November 2006, we carry out 11 times observations for seafloor positioning at northeastern array of seafloor transponders, which are installed at about 800 meter depth. In this presentation, we will evaluate the analysis method for seafloor positioning through the observed data analysis.

Analysis method

This analysis method determines both the weighted center of a seafloor transponder array and temporal change of acoustic velocity. We used cubic B-spline functions [Barnhill and Riesenfeld, 1974] as basis functions to express the smoothed temporal change of acoustic velocity. The smoothness was represented by first order derivative of temporal change of acoustic velocity. We determined the hyper parameter which gives the most suitable smoothness by following two steps. 1) After dividing the two group dataset from all dataset with keeping the distribution, we carry out the seafloor positioning analysis for two halves and full dataset with various hyper parameters. 2) We adopted a best hyper parameter which calculates the closest seafloor positions by between each half and full dataset.

Acoustic ranging with respect to a number of seafloor transponders can estimate the temporal change of acoustic velocity accurately. On the other hand, Acoustic ranging with respect to one seafloor transponders continuously can not estimate the suitable temporal change of it. To estimate the temporal change of acoustic velocity correctly, we constrained the height component of all seafloor transponders on seafloor positioning. As a result, determined positions of weight center of seafloor transponders array was the north-south component. To evaluate the performance of this method and to evaluate the result, we carried out a synthetic experiment. We made synthetic travel-time data using certain velocity models and proper accidental errors with actual vessel positions. Through the synthetic experiments, we will discuss conditions for good repeatability of seafloor positioning.