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Problems and proposition in high-accurate seafloor geodesy

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Several problems in the higher-accuracy seafloor geodesy in terms of GPS/acoustic technique have been revealed through surveys and research during several years of the DONET project. Some of the problems have been already overcome, which contributed to the improvement in seafloor positioning. For example, for the effect of sound speed variation in seawater, we have developed a survey layout and an analytic algorithm to simultaneously solve vertically averaged sound speed and position of an transponder array as time series, without severe maintenance of survey position during the stationary survey. This have been proved by independent oceanographic measurement during the survey. The accuracy of the seafloor positioning is kept to some extent using this method, however, it also found that the lateral variation of sound speed cannot be negligible when one aspires much higher accuracy. When the length scale of the lateral variation is much greater than horizontal extent of a transponder array, say depth of water, it can be reasonably approximated by linear function as a gradient of the field, which can minimize the increase of the unknown parameter to be solved. Kido (2007) , with above assumption, theoretically proved that averaged sound speed and its gradient as well as position of the transponder array can be solved all at once as time series using five transponders with appropriate survey position. However, applying observed data to the new algorithm, we found many situations that the linear approximation to express the lateral variation cannot be applicable, i.e. short wavelength component of the variation is matched or smaller than length scale of ocean depth.

In this presentation, we show synthetic traveltime residuals for the case of the linear approximation, as compared with actually observed residuals. Analyzing the difference in the behavior of the two residuals, we address the typical nature of the lateral scale of the sound speed variation and its time variation. In final, we propose intensive survey with extensive instrument to reveal nature of sound speed structure in ocean for further improvement in the GPS/acoustic measurement.

Keywords: GPS/Acoustic, sound speed, acoustic ranging, Kumano-nada