Intensive XBT measurement reveals short-period gravitational internal wave in the sea: its impact on GNSS/acoustic seafloor geodetic survey

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GNSS/acoustic measurement, consisting kinematic-GNSS monitoring of a sea-surface platform and acoustic ranging to seafloor transponders, is significantly affected by temporal variation of sound speed structure in seawater. In most cases, it can be well approximated with a time-varying laterally stratified structure. Therefore, we usually assume this condition in the GNSS/acoustic analysis. Any violation of this assumption results in apparent fluctuation of horizontal position of transponders. The fluctuation generally shows unstable long-timescale feature (several hours to a day), but sometimes shows clear periodic feature (0.5-1 hour). Such a short-timescale periodic feature can be interpreted by gravitational internal wave. Its quantitative contribution to the GNSS/acoustic analysis highly relies on local horizontal gradient of the field, which is the product of vertical gradient of sound speed, wave amplitude, and inverse wavelength of the internal wave. However, no direct observational evidence of this hypothesis has been available so far.

Then we conducted intensive XBT profiling of water column concurrently with GNSS/acoustic point survey in Kumano-nada, Nankai trough in 2016. Total 12 XBT-based temperature profiles with an interval of 10 minutes (lasting 2 hours), and a single XCTD-based density profile at the end were obtained, which provide fundamental information on the wave period. In the temperature profiles, we clearly identify up to 20 m of vertical oscillation of the water column shallower than 600 m. In the next step, we will estimate horizontal wavelength of this observed internal wave and calculate the local horizontal gradient of the net sound speed structure in order to be compared with apparent horizontal fluctuation observed in the concurrent GNSS/acoustic survey. These fundamental data in the water column will also contribute to understand small fluctuation in pressure at ocean bottom.

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