GNSS-Acoustic observations using a Wave Glider and their results

*Fumiaki Tomita[1], Takeshi Iinuma[1], Motoyuki Kido[2], Yusaku Ohta[3], Chie Honsho[3], Tatsuya Fukuda[1], Takane Hori[1]

1. Japan Agency for Marine-Earth Science and Technology, 2. International Research Institute of Disaster Science, Tohoku University, 3. Graduate School of Science, Tohoku University

Using the GNSS-Acoustic (GNSS-A) observation technique, seafloor crustal deformation associated with an earthquake cycle has been measured [e.g., Honsho et al., 2019, JGR]. A sea-surface platform, which conducts GNSS measurement and acoustic ranging between the sea-surface and the seafloor, is essential for the GNSS-A observation; in general, a research vessel has been used. However, employment of a research vessel requires high financial and human resources, which makes frequent GNSS-A observations for many sites difficult. Then, JAMSTEC and Tohoku University have developed system for GNSS-A observations using a Wave Glider (WG) as the sea-surface platform. The WG is an unmanned surface vehicle which can move by sea-surface wave energy. We conducted a trial short-term observation using the WG at single site in July 2019, and we showed that precision of the GNSS-A measurements using the WG was comparable with that using research vessels [Iinuma et al., 2021, Frontiers in Earth Science]. Moreover, we successfully operated the WG in June–July 2020 and conducted GNSS-A observations at 14 sites [Tomita et al., 2020, GSJ Meeting]. In this study, we report outline of the GNSS-A observation using the Wave Glider in Oct. 2020 and its results. Although we also simply report the results of the observation in Nov.–Dec. 2020, this observation was conducted as urgent survey associated with activation of seismicity off northern Sanriku from early Nov. 2020; thus, its outline is reported by Hori et al. [this meeting], and its technical issues are reported by Kido et al. [this meeting].

The WG equipped GNSS-A observation instruments and Thuraya satellite communication instruments for confirming state of the obtained data. The equipped GNSS-A instruments are following: two GNSS antennas for position and attitude (heading and pitch) of the sea-surface platform, an acoustic ranging unit, an acoustic transducer, and a MEMS gyro. The Wave Glider was deployed at G24 site on Oct. 8 during the KS-20-16 cruise. After the observation for 25 days, it was recovered by a charter vessel at G13 site on Nov. 1. Although GNSS data was unavailable because of the logging system error at one site, we successfully obtained the observational data in the other sites.

We estimated horizontal displacement of the seafloor transponder array for each acoustic ping by the means of Kido et al. [2006, EPS]. The initial geometry of the transponder array was calculated by Honsho et al. [2019] using the past observational data. We then calculated average and standard deviation of the horizontal displacement during the survey for each site. We found that the temporal variations of the horizontal array position for each ping were generally large, which suggested that spatial variation in the underwater sound speed structure was complex during the observation in Oct. 2020. Although precision of the horizontal displacements in Oct. 2020 was relatively larger than the past cruises, we successfully obtained the analysis results.

Although we had conducted at least one GNSS-A observation cruise for each site per a year in the off-Tohoku region before 2016, we have hardly conducted the cruises after 2016 due to the operating cost of vessels. However, we conducted the surveys for most GNSS-A sites off Miyagi–Aomori in 2020 using the WG. Off Iwate and Aomori, the displacement rates had been small in the previous studies, and this characteristic was also confirmed in the latest results. Meanwhile, off Miyagi, large landward motions

had been observed due to the viscoelastic relaxation of the 2011 Tohoku-oki earthquake; we found that the landward motions were still continued from the latest results, but their displacement rates were little smaller than the previous studies.

In the presentation, we will introduce outline of the observations using the WG, and we will discuss the present postseismic deformation associated with the 2011 Tohoku-oki earthquake for the horizontal components. Note that vertical motions in the whole off-Tohoku region will be discussed by Honsho et al. [this meeting].

Keywords: GNSS-Acoustic observation, Wave Glider, Seafloor geodetic observation, Crustal deformation, The 2011 Tohoku-oki earthquake

