Beamforming detection of possible tsunami forerunners at the Korean coast

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Korea is mostly surrounded by sea and the west and south offshore have shallow depth which is 51 m and 71 m of the average depth respectively. The eastern sea of Korea has relatively deeper average depth (about 1,497 m) as well as it increases rapidly along the coast, so the sea between the eastern Korean Peninsula and the Japanese Arc is such as a huge bath. When the 2011 Tohoku earthquake occurred, it not only generated a devastating tsunami in the Sanriku region, but also caused small waves in the back-arc region of Japan. They were recorded at several tidal gauges along the coast of the East Sea (Japan Sea) (e.g. Shevchenko et al., 2014; Murotani et al., 2015), and Murotani et al. referred to them as “tsunami forerunner”. The Nankai Trough, which is located to the southeast of Japan, is one of the regions capable of producing a large M9 earthquake in the future (Parsons et al. 2012). Therefore, there is a reason to believe that a potential earthquake may cause sea waves originating in southeastern Japan to reach the Korean Peninsula. In this study, we explore whether a large Nankai earthquake will produce a tsunami forerunner in the back-arc region of Japan observable on the Korean coast. We conducted a numerical tsunami simulation to obtain synthetic waveforms using a 1707 Hoei earthquake model proposed by Furumura et al. (2011). We created two virtual arrays, AR01 and AR02, to obtain synthetic waveforms. Array AR01 is located to the southeast of Korea to detect the tsunami forerunner and array AR02 is between southern Korea and Kyushu Island to record the main tsunami coming from the Nankai Trough. We then used beamforming analysis to verify the direction of tsunami arrivals using simulated waveforms at the two arrays. We determine the direction of a tsunami forerunner using waveforms from array AR01. Because the wave front of the tsunami forerunner is parallel to the array, waves generated in the northwest region of Japan show a back-azimuth angle that points in the north and north-northwestern directions. The distribution of beam-energy at array AR02 clearly shows that the main tsunami generated in the Nankai trough comes from the southeast. The beam-forming technique using tsunami waveforms is not able to accurately determine the direction of tsunami forerunner arrivals because the amplitude of the waves is small and the region has strongly varying bathymetry.

Keywords: tsunami, beamforming detection, Korean coast

