

Relationship Between the Maximum Heights of the Air-coupled and Eruptive Tsunamis

*Kusumoto Satoshi¹, Yuchen Wang¹, Kentaro Imai¹

1. JAMSTEC

Around 1 p.m. Japan Standard Time (JST) on 15 January 2022, an explosive eruption of the Hunga Tonga-Hunga Ha'apai submarine volcano off the coast of Tonga in the South Pacific Ocean occurred and it caused tsunamis that reached many countries along the Pacific coast. Initially, the Japan Meteorological Agency (JMA) reported that there are no significant sea level changes in the coastal areas. However, abnormal sea level changes of >1 m in height, which be related to the Lamb waves, were observed at 8-9 p.m. JST (air-coupled tsunami; Pakoksung *et al.*, 2022) and the JMA issued tsunami warning at the midnight. The tsunamis repeatedly rushed in the coastal areas (eruptive tsunami; Pakoksung *et al.*, 2022) and the tsunami warning was canceled at 2 p.m. JST on 16 January. This tsunami event has some irregular factors. Major one is that the air-couple tsunami arrived in Japan several hours earlier than expected. This is due to the Lamb waves traveling through the atmosphere at the speed of sound. Another is that tsunami heights were much larger than the forecasting. There are several suggestions, however the details are still unknown.

In this study, we focused on the maximum heights of the air-coupled and eruptive tsunamis. First, the ocean tide was removed by a high-pass filter with cut-off period of 128 min. Next, taking advantage of the different propagation velocities of the Lamb waves and tsunamis, the air-coupled tsunamis and the eruptive tsunamis were separated by the Tsunami Travel Time software. Finally, we examine the correlation of the maximum heights of them. Our result indicated that the maximum heights of air-coupled tsunamis have a strong positive correlation with that of the eruptive tsunamis. The characteristics were not identified in deep ocean water-pressure gauges such as Deep-ocean Assessment and Reporting of Tsunamis buoys, suggesting that it is possible to be related to wave shoaling. Further researches are needed because the same phenomenon may have occurred in the volcanic eruption of Mt. Fuji with 1707 CE Hoei Nankai earthquake.

Acknowledgments: This study was supported by the project “Research project for compound disaster mitigation on the great earthquakes and tsunamis around the Nankai trough region” of the Ministry of Education, Culture, Sports, Science and Technology Japan (MEXT). The observed waveforms were provided by JMA, Japan Oceanographic Data Center (JODC), and NOAA.

Keywords: Tsunami, Tonga volcanic eruption, Wave shoaling