Global simulations of meteotsunamis excited by the 2022 Tonga eruption

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The Hunga Tonga–Hunga Ha'apai volcano erupted around 13 JST on 15 January 2022, and surface pressure anomalies of around 2 hPa as well as tidal fluctuations caused by meteotsunamis were observed over Japan. In order to investigate the generation and propagation mechanisms of the observed pressure anomalies and meteotsunamis, plume-atmosphere-ocean coupled simulations which can represent from the excitation mechanism of atmospheric waves to the ocean response are needed. As a first step, numerical experiments were conducted using the global atmospheric non-hydrostatic model NICAM (horizontal resolution 14 km, 78-layer, model top 50 km) to investigate what kind of atmospheric waves are generated by placing a thermal just above the volcano. The output was used to drive the global ocean general circulation model COCO (63 layers with a horizontal resolution of 0.1˚) to investigate what kind of ocean waves are excited and propagated.
NICAM showed strong excitation of sea-level pressure anomalies propagating from volcanoes at about 300 m/s and 225 m/s, which correspond to the Lamb wave and atmospheric gravity wave, respectively. The pressure anomalies associated with the Lamb waves were one order of magnitude smaller than observed. COCO driven by sea level pressure in NICAM propagated sea level height anomalies corresponding to Lamb and atmospheric gravity waves, respectively. Although the amplitude of the sea level pressure anomalies was larger for the Lamb waves, the sea level height anomalies corresponding to the atmospheric gravity waves were larger due to resonance with shallow water waves. NICAM experiments will be conducted using the output of the plume model for realistic simulations.

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