EGU24-20633, updated on 19 Jan 2025
https://doi.org/10.5194/egusphere-egu24-20633
EGU General Assembly 2024

The Impact of Volcano-Generated Tsunamis on the Safety of Moored Vessels: The 2022 Tonga Incident.

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The atmospheric tsunami resulting from the eruption of the Tonga volcano on January 15, 2022 (Tonga22) marked an unprecedented occurrence, encompassing a Volcano-Meteorological Tsunami (VMT) with global ramifications. This study examines the comprehensive effects of Tonga22 on moored vessels, employing a spectral and hydrodynamic analytical framework. The aftermath of the event, including edge waves, resonance phenomena, and wave amplification in specific regions such as La Pampilla port in Peru, revealed substantial maritime challenges. Notably, a vessel in La Pampilla reported the rupture of mooring ropes, a remarkable incident occurring 10,000 kilometers away from the Tonga volcano, manifesting 15 hours post-eruption and resulting in the spillage of over 11,000 barrels of crude oil.

Our research aims to contribute to a nuanced understanding of the Tonga22 event by employing advanced spectral and hydrodynamic analyses. The primary focus lies in assessing its impact on mooring loads within the complex marine port environment. We postulate that atmospheric acoustic waves, a consequence of the volcanic eruption, pose hydrodynamic threats to vessels in port areas, potentially leading to mooring breakage.

Utilizing the Boussinesq model, validated at the local scale in Callao Bay, we establish a foundation for our mooring system model. This model, applied to a vessel analogous to the one docked at La Pampilla Port, aims to discern the nuanced influence of VMT on overstressing and mooring breakage during the Tonga22 event.

Our simulation results underscore the pivotal role of VMT in the displacement and loss of positioning of vessels. Moreover, atmospheric waves are revealed to significantly elevate mooring stresses, with a particular emphasis on the starboard quarter moorings in this specific case.

This research sheds light on a critical realization—the Tonga22 event highlights the inadequacies of existing tsunami early warning systems (TWC) in detecting and managing tsunamis induced by acoustic waves originating from volcanic sources. These findings contribute to the ongoing discourse on maritime safety and hazard preparedness.