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Were the 2022 Tonga Eruption Meteotsunamis Caused by the Proudman Resonant?

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This study uses numerical methods to explore the causes of meteotsunamis in the Atlantic Ocean, Caribbean Sea, and the Mediterranean Sea after the eruption of the Tonga Volcano on January 15, 2022. Topics are focused on the role of the Proudman resonant effect on the tsunami induced by the Lamb waves. The linear and nonlinear shallow water equation, fully-nonlinear and weakly-dispersive Boussinesq equations, weakly-nonlinear and weakly-dispersion Boussinesq equations, and the three-dimensional Navier Stokes equations are solved for simulating and discussing the phenomena of the Tonga Tsunami. In terms of boundary conditions, the atmospheric pressure data from the Central Weather Bureau of Taiwan and the pressure data from the ten-meter meteorological tower of the Central University are used. In terms of model verification, the free-surface elevation data of the tide station recorded by the Central Weather Bureau of Taiwan and the pressure data of the undersea cable are used. A wide range of Froude numbers of the moving pressure is introduced for understanding the effect of the Proudman resonant. The result shows that the free-surface elevation is positive right under the moving pressure if Fr>1.0, a negative free-surface elevation is observed if Fr <=1.0. In the end, the moving-solid algorithm is introduced in the Navier-Stokes model for studying the stern wave generated by the moving pressure. The result shows that the wave amplification factor is about 5 in the case of Proudman resonant of the bow wave, and it is about 1.2 in the case of Tonga Tsunami. However, the wave amplification factor of the stern waves reaches 20 in the case of the Tonga Tsunami. Detailed results and discussion will be presented at the conference.

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