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Impact Effects & Consequences

TONGA TSUNAMI PROVIDES DATA, VERIFICATION FOR BLAST-GENERATED GLOBAL TSUNAMI MODELING

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ABSTRACT

On January 15, 2022, the Hunga-Tonga Hunga-Ha'apai volcano, located approximately 60 km north of Fua'amotu, the main island of Tonga, violently erupted with a powerful explosion, culminating the period of volcanic activity that started in December of 2021. The event generated unexpectedly strong tsunami that was recorded all over the Pacific Ocean. Tsunami waves were also reported in other ocean basins, including the Caribbean and Mediterranean seas. Traditional tsunami-generation mechanisms, including caldera collapse, landslides and underwater volcano slope failures, struggle to explain the observed tsunami waves around the world. Mounting evidence quickly pointed toward an unorthodox tsunami generation mechanism – forcing by propagating acoustic gravity waves (a.k.a atmospheric Lamb waves) originated from the volcanic blast. The Lamb wave tsunami generation is the only mechanism capable of accounting for the unexpected times of arrival observed globally and generation of tsunamis at different ocean basins. It appears that the local impact of tsunami in Tonga is also explained well by the Lamb wave-forced tsunami, implying that the pressure forcing from the volcanic blast is the major (if not the only) source of the January 15, 2022 Tonga tsunami.

The Lamb wave forcing of tsunami is similar to the formation of meteotsunamis from weather systems and to the gravity waves formation from other large atmospheric explosions like meteorite impacts, including the role of Proudman resonance to amplify the wave in certain directions. Those generation mechanisms have been studied before, however, the January 15, 2022 Tonga tsunami is the first event that proved the existence of air-pressure coupling mechanism for tsunami generation during the blast events. It also provided ample data for the model verification and testing.

We present results of ongoing modeling efforts to simulate the 2022 Tonga tsunami employing atmospheric pressure wave forcing and compare our results with sea-level and atmospheric pressure observations in the Pacific and around the world.

Comments:

Prefer oral presentation