

Lamb wave propagation from the eruption of Hunga Tonga-Hunga Ha 'apai visualized by Himawari-8 infrared images

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A Lamb wave in the atmosphere is a type of acoustic waves traveling at about 300 m/s. Lamb waves propagate in the horizontal directions only, in the case of an isothermal atmosphere at rest. They are generated by large pressure pulses, such as volcanic eruptions, earthquakes, meteors, and atomic bombs. One of the most famous events was the 1883 eruption of Krakatau in Indonesia.

The major eruption of volcano Hunga Tonga-Hunga Ha 'apai in Tonga on 15 January 2022 generated the atmospheric Lamb waves, that propagated over the whole globe. The wave propagation was clearly captured by geostationary weather satellites. Because the magnitude of the event is the largest since the start of weather satellite observations, it is worth investigating. Therefore, this study attempts to visualize the Lamb waves clearly, using state-of-the-art geostationary satellite Himawari-8.

In this study, one of the water vapor channels of Himawari-8 is used. The second time derivatives of 10-minute interval images clearly visualized the wave patterns. The propagation speed is estimated as 3.12×10^2 m/s, which matches the theoretical value well. Himawari's differential images could track the waves for more than 7 days while the waves traveled the whole globe for five times. In contrast, if the time interval of the time derivative was changed to 30 minutes, which was a typical value for the previous-generation geostationary satellites, the wave patterns were not clearly visualized. The signal in the satellite imagery was consistent with the surface pressure observations in Japan.

Keywords: Lamb wave, Himawari-8, Hunga Tonga-Hunga Ha 'apai