# Relationship between the Lamb wave propagation and the satellite-observed brightness temperature variance: a simple theoretical estimate

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On 15 January 2022, the eruption of Hunga Tonga-Hunga Ha’apai generated Lamb waves, that have been captured by geostationary meteorological satellites. Those waves were clearly visualized by taking the second time derivative of the brightness temperature (Tbb) of the upper-tropospheric water vapor channel at the wavelength of 6.2 $\mu$m (Otsuka 2022, under review). Although it is apparent that the wave signals in the satellite images were generated by the eruption, it is also worth investigating the mechanism that generated the Tbb variance.

In principle, Lamb waves generate adiabatic motions. Therefore, the amplitudes of pressure, temperature, and density perturbations can be estimated if one of them is observed. Based on the pressure change of 1-2 hPa observed at the surface stations in Japan, one can estimate the pressure perturbation in the upper troposphere, using the vertical structure of Lamb waves for an isothermal atmosphere. Corresponding temperature perturbation in the upper troposphere becomes about 0.1 K, which explains most of the Tbb variance. In contrast, the change in density leads to a change in the weighting function of the satellite radiance observation by changing water vapor mass. The sign of this effect is opposite to that of temperature perturbation, and the amplitude of corresponding Tbb variance is about 0.01 K. Because these estimates are based on a simple atmospheric structure, further analyses are needed with a realistic atmospheric profile and a radiative transfer model.

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