Theoretical consideration of the excitation of atmospheric Lamb waves by tsunamis

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Major tsunamis have been known to excite significant atmospheric Lamb waves (e.g. Arai et al 2011; Mikumo et al 2008), whose signals captured by networks of microbarometers are potentially useful to inverse the sea level perturbation in tsunami source regions. In such attempts, the pressure perturbation in the tsunami source region has been estimated to be p = ρ c w (c: speed of the sound wave, ρ : atmospheric density, w: vertical velocity of the sea surface). However, the validity of the estimation, which is based on the properties of usual sound waves, is questionable for the cases where different kinds of waves, i.e., internal gravity waves, acoustic-gravity waves, and Lamb waves, are excited. In fact, Watada(2009) has examined the response of an isothermal atmosphere to the bottom displacement in the frequency-wavenumber domain, and has shown a variety of impedance corresponding to the dispersion relations of different kinds of waves. So, examination of the response in the real space is desirable. In the past, however, only the investigations on the realistic fault parameters has been performed (e.g., Isumiya and Nagaoka, 1994), which are not necessarily suitable for understandings basic properties of response. In the present study, more idealistic set-ups are employed in order to gain theoretical interpretation.

We solve two-dimensional linearized compressible equations of isothermal atmosphere forced by a prescribed evolution of vertical flow at the bottom simulating the effect of tsunamis. The computational domain covers 2000km horizontally and 100km vertically, whose upper 20km is the sponge layer. Two kinds of vertical flow are considered. The first one is a space-time Gaussian pulse simulating a sea surface rise following a fault motion, whose characteristic time is varied from 10 s to 300 s. The second considers horizontally moving Gaussian sea surface rise simulating the propagation of tsunami wave, whose propagation speed is varied from 25m/s to 300m/s. The basic equations are discretized employing spmodel (Takehiro et al 2013). Results will be presented in the presentation and discussed focusing mainly the excitation of Lamb waves, which has no vertical motion in the modal structure, are excited by the vertical displacement at the bottom boundary.

References

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