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Acoustic resonant oscillations between the atmosphere and the solid earth during the 1991 Mt. Pinatubo eruption

Shingo Watada[1*], Hiroo Kanamori[2]

[1]ERI, University of Tokyo, [2]Seismolab Caltech

Long-period harmonic Rayleigh waves were observed on seismometers during the 1991 Mt. Pinatubo eruption in the Philippines. The amplitude spectrum of the Rayleigh waves shows two distinct peaks at periods of about 230 and 270 s. In the Earth's atmosphere, long-wavelength standing acoustic waves are bounded in a low-sound-velocity channel between the thermosphere and the ground. The Rayleigh waves and the fundamental and first overtone of atmospheric acoustic waves trapped in the low-sound-velocity channels have approximately the same horizontal wavelength and frequency at periods of 230 and 270 s, respectively, i.e., the atmosphere and the solid earth satisfy the condition for acoustic resonant oscillations. The standing atmospheric long-wavelength acoustic waves set off by the eruption selectively excited seismic spheroidal modes near the resonant period through acoustic resonant coupling and resulted in harmonic Rayleigh waves. In contrast, gravity waves and Lamb waves (atmospheric boundary waves) do not couple to the ground efficiently and are not easily observed as ground disturbance on seismograms during volcanic eruptions.

Keywords: Rayleigh waves, Mt. Pinatubo eruption, resonance between the atmosphere and solid Earth,, harmonic ground motion, air-ground coupling, anomalous excitation of spheroidal mode