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Numerical simulations of atmospheric perturbation from the lower atmosphere

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It is said that oscillations of about 4 mHz having been observed so far such as ionospheric disturbances at severe weather [e.g., Davies and Jones, 1971; Prasad et al., 1975] and just after earthquakes[e.g., Heki and Ping, 2005], geomagnetic pulsation just after a large earthquake [Iyemori et al., 2005], Earth's background free oscillations [e.g., Nishida et al., 2000] are all caused by acoustic-gravity wave resonance between the ground and the lower thermosphere. The resonance itself, however, has not been confirmed by observations, and the feature is not clear yet. It has been declared with atmospheric pressure observations on the ground that atmospheric perturbations of about 3.7 mHz [Matsumura et al., 2010, in press], one of the resonance frequency theoretically expected, often occur. The confirmation, however, is not complete because observations around mesopause, where acoustic waves reflect, are difficult. The feature of the resonance, therefore, is still unknown.
In this report, numerical simulations are performed to make up for the observational information and to estimate the feature of resonance.
In the simulation, a two-dimensional nonhydrostatic compressible neutral atmosphere model is used. The simulations are performed for two cases. In one case, heating source is given, where a severe weather situation is assumed. In the other case, vertical wind on the ground is given, where an earthquake or a volcanic eruption is assumed.
As a result, in both cases, amplitude of waves grows and attenuates once and grows again at various altitudes just above the center of the wave sources. It is shown from the phase analysis that waves of about 4 mHz propagating upward are reflected around the mesopause, propagate downward and are reflected at the ground or the tropopause and propagate upward again. The second growth of amplitude is seen in the observational result of a ionospheric disturbance at the eruption of Asama volcano on September 1, 2004, in which HF Doppler method was used.
The simulations show that perturbations generated at lower atmosphere propagate also above 100 km and the amplitude of them is much greater than that below the 100km. On the other hand, the energy of waves below is much greater and this shows that the energy is trapped below through the reflection around the mesopause.
Furthermore, spectrum analyses show that frequencies of perturbations are between 3 and 6 mHz, and they vary depending on the altitude and time.
In the future this model will be improved to the three-dimensional one including ionospheric disturbances and electromagnetic variations caused by it.