The linear response of the coupled atmosphere-solid earth system to the fluctuating condensation of water vapor in the troposphere

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1. Continuous free oscillations of the solid earth and their possible excitation source

It has been revealed recently that continuous oscillations of the solid earth are excited by phenomena other than earthquakes (Kobayashi and Nishida, 1998, etc.). Since the oscillations are fundamental spheroidal-modes, their excitation sources presumably lie at or just above the earth's surface, i.e. the atmosphere and the ocean. Furthermore, the oscillation spectrum has excess peaks on the modes ${}_0S_{29}$ and ${}_0S_{37}$ which have the potential to resonate with the atmosphere (Nishida et al. 2000). Some specific excitation mechanisms are suggested: for example, oceanic infragravity waves accompanied by marine storms (Rhie and Romanowicz, 2004), globally distributed atmospheric turbulence in the surface boundary layer (Fukao et al. 2002), heating by cumulus cloud convections (Nakajima and Notsuhara, 2001 Atmospheric Science Symposium at ISAS), and so on.

2. Clouds as the excitation sources

Nakajima and Notsuhara (2001) discussed that the modes ${}_0S_{29}$ and ${}_0S_{37}$ can be excited strongly by fluctuating heating in many cumulus clouds occurring over the earth's surface. A numerical experiment on clouds using a fluid dynamical model shows that variations in surface pressure at tens to hundreds of seconds are caused by atmospheric mass variations and heating associated with condensation of water vapor (Tashima and Nakajima, 2007 Fall Meeting of Meteorological Society of Japan). These arguments on clouds, however, deal only with the atmosphere; it is not clear how the solid earth responds to the surface pressure perturbations induced by clouds.

3. Response of the coupled atmosphere-solid earth system to clouds

We develop a coupled model of the atmosphere and the solid earth and examine its response to fluctuating activities of clouds. In Fukao et al. (2002) and other previous studies, the response of the system is calculated as a summation of free oscillation modes. In the method we use, in contrast, a direct linear response of the coupled atmosphere-solid earth system to atmospheric mass variations and heating is solved. The system we use is Fourier transformed in time domain and expanded in spherical harmonics, and the radial equations are integrated by using the method of Kobayashi (2007).

At present, the test calculations on the system composed of a viscous homogeneous sphere covered by an isothermal atmosphere is working. The case of a standard atmosphere on the preliminary reference Earth model (PREM) will also be investigated and reported.