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Planetary free oscillations by the mountain wave on Mars

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We now have a plenty of information about the surface condition of Mars. With these as constraints we understand fairly well how the martian climate system works. On the other hand,as for the internal structure little is known because of the lacking of high quality data to constrain. Recently several exploration programs have been proposed to conduct seismic observations for better understanding of the internal structure of Mars. Under the limitation of numbers of seismometer which can be installed on Mars, observation of free oscillations is one of the proposed target.

The feasibility of this research strongly relies on the excitation source and its magnitude. Comparing to the earth, low tectonic activity is expected because of lack of plate tectonics. Large marsquakes which can excite global free oscillations are hardly expected to occur in limited observational period. In this presentation, we explore the possibility of atmospheric excitation for the free oscillations.

Recently it has been widely recognized that atmospheric disturbances are continuously exciting the Earth's free oscillations (Kobayashi and Nishida, 1998 a,b; Tanimoto 1999; Nishida et al., 2000). If disturbances in the martian atmosphere can also excite, frequency band and its magnitude can refine the design of the seismometer and the observational program. Strong disturbances are expected in the martian atmosphere but at the same time low atmospheric density would reduce magnitude of the coupling between atmosphere and ground. Detailed evaluations are needed. In this study among various styles of the atmospheric transient disturbances we focus on the mountain lee wave activity.

The mountain lee wave is excited when the wind passes over mountains. We can recognize its formation by unique clouds on Earth and Mars. The theory of mountain lee wave has been discussed in a series of papers by Scorer (1949, 1953, 1954), and in particular for an isolated peak by Scorer (1956), and Scorer and Wilkinson (1956). Several cases were observed during the Mariner 9 mission and interpretation on the wind profile with height. Pirraglia (1976) analyzed several vertical structures in the atmospheric flow by using a two-layer formulation with different wind speeds though in the same direction. The model also considers waves excited by a single, isolated crater. This approach was developed further by Pickersgill and Hunt (1979) who allowed the static stability to vary with height as well as the wind speed. Pickersgill and Hunt further extended their analysis to the formation of lee waves generated by single, isolated mountains such as the giant volcanoes on the Tharsis Plateau (Pickersgill and Hunt, 1981). Flow around isolated peaks can be significantly more complicated than over mountain ridges, because the static stability may restrict vertical motion at low levels so that air flows horizontally around the mountain rather than over it (e.g., Bainse, 1995).

In this study, we estimate the amplitude and frequency of the surface pressure due to mountain waves based on the simple model. The model basically follows the Pickersgill and Hunt's incorporated recent atmospheric structure and its seasonal variation. We can understand whether mountain lee waves can excite the planetary free oscillations or not by comparing the natural oscillation of Mars and fluctuation of surface air pressure.