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Global seismic waveform modeling in the whole Mars - a preliminary study -

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We calculate global seismic wave propagation on cross sections of realistic whole Mars models.

Estimation of Martian inner structure has been one of the most attractive topics in planetary science for decades. Indirect estimation of Martian interior has been attempted via various pieces of information such as cosmochemical data from the Martian meteorites, and planetophysical data such as the moment of inertia. Especially, Sohl & Spohn (1997, JGR) had proposed two end-member standard Mars models of density and seismic wavespeeds named “model A” and “model B” constructed in order to satisfy certain values of the polar moment of inertia and the bulk chondritic Fe/Si ratio, respectively.

Seismological estimation of the Martian inner structure is the next step although up to now only a possible small seismic event was detected during five months of operation of Viking 2 seismometer emplaced on Mars in 1976 (Anderson et al., 1977, JGR). Currently, preparation for the Japanese next Mars exploration mission MELOS is progressing, which contains a plan to install broad-band seismometers on Martian surface (e.g., Kurita et al., 2009, JPGU Meeting). Looking back on investigation history of the Earth’s interior, our knowledge has been enhanced by mutual progress of observation and numerical methods. Increased enthusiasm for Mars exploration in recent years strongly requires developing a method for numerical modeling of global seismic wave propagation based on our current knowledge of Martian interior.

We have been constructing numerical schemes using the finite-difference method (FDM) for accurate and efficient modeling of global seismic wave propagation through realistic Earth models with lateral heterogeneity (e.g., Toyokuni et al., 2005, GRL; Toyokuni & Takenaka, 2006, EPS). Our scheme calculates the 3-D equations of seismic waves in spherical coordinates only on a 2-D cross section of the whole Earth including a seismic source and receivers (spherical 2.5-D FDM), which enables global waveform modeling with the similar computation time and memory as for 2-D modeling with consideration of full 3-D geometrical spreading. This time we apply it to model global seismic wave propagation in the whole Mars. In the presentation, we will show some numerical examples using models with realistic Martian crustal thickness superimposed on the “model A” and “model B” of Sohl & Spohn (1997, JGR).

Keywords: Mars, seismology, seismic wave propagation, synthetic seismogram, global modeling, finite-difference method (FDM)