Bayesian modeling of the equation-of-state for liquid iron under high-*P* and high-*T* conditions corresponding to the Earth's outer core

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We demonstrate Bayesian modeling of the equation-of-state (EoS) by using experimental data sets to constrain the density (ρ) and the P-wave velocity (V_P) of liquid iron under high–pressure (P) and high–temperature (T) conditions corresponding to the Earth's outer core. As an experiment under the conditions of high–P and high–T is still technically challenging, an optimization of the parameters of EoS is required to be performed efficiently by using small amount of data sets including unobservable data. To analyze such data sets, the parameters and unobservable data were assumed to be random variables in the Bayesian inference, and the Hamiltonian Monte Carlo method successfully calculated the posterior probability density functions of the parameters and unobservable data. These posterior densities enable us to estimate the EoS curves with the credible intervals and the P–ρ and P–V_P relations of liquid iron along the adiabatic P–T paths corresponding to the Earth's outer core. The P–ρ and P–V_P relations showed that the deviations of ρ and V_P from the preliminary reference Earth model are in the ranges of 8–10% and -3–-5%, respectively, when the temperature at the core-mantle boundary is assumed to be in the range of 3500–4200K.

Keywords: Bayesian inference, Equation-of-state, Liquid iron, Earth's outer core

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