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A Numerical Estimation of Magnetic Induction by the Venusian Core

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The deep layers of Venus are usually modelled from the Earth's structure as scaled to the mass and radius of Venus, but the parameters of these layers, including the size of the Venusian core, remain unknown. Magnetic sounding provides a means to estimate the size of the metallic core using measurements by past and ongoing Venus missions. One approach of magnetic sounding is to measure the induced dipole moment of the core at low altitudes. At Venus, the magnetic field induced by the solar wind interaction with the planet should also be considered to properly estimate the total magnetic induction.

In this study, we numerically model the magnetic induction within the Venusian magnetosphere. As a first attempt, our analysis is focused on a simplified two-dimensional geometry in the noon-midnight meridian. The calculation of magnetic induction is performed by the finite element method that considers the geometry and boundary conditions pertinent to the interior structure and the induced magnetosphere of Venus. The results show that magnetic field lines drape around the core on the dayside and that the field is more aligned to the tail direction at locations past the terminator. For the magnetic field anticipated by low-altitude spacecraft, the field is nearly horizontal on the dayside, and the magnitude of the dip angle increases as the spacecraft enters the nightside. When the spacecraft locations are at large solar zenith angles, the magnetic field is nearly vertical, and the dip angle rises faster when the core radius is greater, because the magnetic field direction is altered more when the distance between the core and the central tail current is shorter. We will also discuss the comparison between the modeled results and the Venus Express observations at low altitudes as well as the implications.