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Downward continuation of the Earth's geomagnetic field through an ellectrically conducting mantle: first application of the adjoint sensitivity method

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The geomagnetic field, observed at the Earth's surface or at satellite altitude, changes significantly by the downward continuation through an electrically conducting mantle to the core-mantle boundary (CMB). In particular, the spatial structure and its time variation up to decadal scales are modified by the induction and diffusion processes in the mantle. The knowledge of the geomagnetic field and its temporal behavior at the CMB, the interface between the mantle and the liquid outer core where the geomagnetic field is generated, is essential to discover and understand the dynamic processes in the Earth's core.

The downward continuation of the geomagnetic field is an one-sided ill-posed boundary-value problem. As an alternative, we prescribe the downward continuation as a two-sided BVP with an initial guess of the geomagnetic field at the CMB. Based on the adjoint formulation of the magnetic induction equation, the sensitivity equations for the adjoint field are set up and solved in a spectral-finite element approximation. The enhancement of the recently developed adjoint sensitivity method for the downward continuation, formulated originally by the geomagnetic vector potential, by using the geomagnetic induction vector for the theoretical description enables an extension for three-dimensional conductivity structures.

The first application is presented here along a comparison of core models obtained by different approaches for a radial conductivity profile only, as, for example, the harmonic downward continuation and the commonly applied perturbation approach.