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Determination of the toroidal geomagnetic field in the lower mantle considering a radial electric conductivity profile

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The determination of the toroidal geomagnetic field at the core-mantle boundary (CMB) is based on the poloidal geomagnetic field and the fluid flow velocity at the CMB. In the first part, we summarize the necessary theoretical description for this initial-boundary value problem. Beside the related time dependent induction equation for the toroidal geomagnetic field, we derive the relation between the boundary values and the poloidal geomagnetic field and the fluid-flow velocity. In this derivation, we represent all field quantities by spherical harmonics. Afterwards, it is possible to reduce the corresponding coupling coefficients to a combination of Clebsch-Gordan coefficients.

In the second part, we illustrate the numerical implementation of the initial-boundary value problem for the calculation of the toroidal geomagnetic field, which is based on a Crank-Nicholson algorithm in time and space. Additionally, we specify the poloidal geomagnetic field model and the fluid-flow velocity field, which are used in the numerical computations.

Moreover, we present the different components of the toroidal geomagnetic field at the CMB for different times and different electric conductivity profiles. This comparison allows us to investigate the influence of the prescribed conductivity profile on the toroidal geomagnetic field.