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Poloidal electromagnetic torques for different conductivity models in the core-mantle transition zone

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To explain the observed variations of the length of day (LOD), it is important to model coupling torques between differently rotating spheres of the Earth.

We investigate the temporal behaviour of the axial component of the electromagnetic (EM) core-mantle coupling torque that is associated with the poloidal part of the geomagnetic field observable at the Earth surface. This (poloidal) torque describes the part of EM core-mantle coupling which can be inferred from the geomagnetic field without assumptions about core motions.

For its computation, we use different model approaches of the magnetic field expansions into spherical harmonics (Wardinski and Holme, Sabaka et.al) and the conductivity, respectively. The three conductivity models used differ by the thickness of shells of equal conductivity in the zone beneath the core-mantle boundary. However, each model has the same radial conductivity distribution in the overlying mantle.

The aim of this study is to explore the influence of sedimentation shells with different thickness near the top of the core on EM coupling. The magnetic field, which we have to know in the core-mantle transition zone for the associated computations, will be inferred from the field at the Earth surface by the non-harmonic field continuation, i.e., in rigorous consideration of a radially symmetric distribution of the electrical conductivity in the mantle and the uppermost core shells.

The foreward modelling of the influence of the toroidal part of the magnetic field on the coupling torque will not be considered here. However, we estimate its values by the difference between the mechanical torque derived from the observed LOD variations (atmospheric influence subtracted) and the poloidal EM torque. These will then be the “data” by which models of the toroidal EM torque can be verified in future.