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Downward continuation of the Earth's geomagnetic field and separation of internal and external contribution from vector magnetic data: consistent application of the adjoint sensitivity method

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There are, among others, two problems related to the determination of the time dependent geomagnetic core field from satellite vector magnetic data; (a) the separation of external and internal contributions to the vector data and (b) the non-harmonic downward continuation of the geomagnetic field through an electrically conducting mantle.

The measured vector components of the geomagnetic field by satellite instruments, provided by the CHAMP and SWARM missions, contain magnetic contributions of various external and internal origins. For studying the dynamics of processes in the outer core and the generated time-variable magnetic field, a separation of the core magnetic field in satellite magnetic observations is needed. Such a separation is complicated since the core magnetic field is altered by the induction and diffusion processes in the electrically conducting mantle. Especially, the effect of these processes is not negligible on the decadal and sub-decadal time scales.

Based on the recently developed adjoint sensitivity method for the downward continuation of global magnetic field, we extend the theoretical formulation for a two-sided boundary-value problem by considering that the X and Z magnetic components, instead of only the internal Gauss's coefficient, is to be specified by satellite observations, and the X component of the magnetic field at the core-mantle boundary is computed. The functionality of the adjoint method is demonstrated for the geomagnetic field model CM4 by Sabaka et al. (2004), which provides time-dependent internal and external contributions to the geomagnetic field.