Paleomagnetospheric processes: field topology, scaling relations, and high-energetic particle fluxes

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Variations of the geomagnetic field on geological time scales affect the structure of the Earth's magnetosphere and the dynamics of high-energetic particles to a similar extent as solar wind induced variations do on much shorter time scales. We have studied structural aspects of paleomagnetospheres using theory, parametric models, and magnetohydrodynamic simulations, and investigated particle dynamics by means of test particle trajectory integrations. The present-day dipolar magnetosphere with a reduced dipole moment serves as a reference case and allows to arrive at scaling relations for large-scale features such as boundary layers and current systems. Since this approach is not suited to describe paleomagnetospheres during geomagnetic polarity transition periods when the topology of the Earth's core field is expected to undergo the most pronounced changes, we make use of magnetohydrodynamic simulations to study how the paleomagnetosphere is affected. The transition field scenarios that we investigate include dipolar magnetospheres where the dipole axis forms a large angle with the rotation axis, and also quadrupolar magnetospheres. Particle trajectory calculations are carried out in magnetic fields from parametric models and from simulations, and the results are used to compute fluxes of high-energetic particles in paleomagnetospheres.