Geophysical Research Abstracts, Vol. 7, 01656, 2005
SRef-ID: 1607-7962/gra/EGU05-A-01656

The origin of the rapid decrease of the geomagnetic dipole moment

P. Olson and H. Amit

Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, MD 21218, USA

The geomagnetic dipole moment is decreasing at about 6% per century, nearly one order of magnitude faster than its theoretical ohmic decay rate in the core. Rapid dipole moment decrease is significant because a sustained decline may indicate instability of the geodynamo. According to the paleomagnetic record, for example, polarity reversals and excursions often begin with a large dipole moment decrease. Maps of the geomagnetic field and its secular variation on the core-mantle boundary indicate that much of the observed decrease in the dipole moment is associated with two phenomena: (i) diffusive growth of reversed magnetic flux regions, and (ii) transport of high-intensity, normal polarity magnetic flux from high to lower latitudes by core flow. These phenomena are particularly active in the southern hemisphere. We combine geomagnetic secular variation data, a model of core flow, and a dipole moment time-evolution equation to quantify the contributions of meridional advection, radial diffusion and meridional diffusion over a century of time. We find that meridional advection and radial magnetic diffusion are nearly equal in magnitude and together account for essentially all of the observed dipole moment decrease. The same combination of mechanisms causes rapid dipole moment decreases in numerical dynamo models. Because meridional advection by core flow and radial magnetic diffusion have worked in unison over the past century, we suggest that the geomagnetic dipole moment decrease will continue.