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Dipole scaling relations in the paleomagnetosphere

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The Earth's internal magnetic field is known to vary dramatically on geological timescales. During geomagnetic polarity transitions, the paleointensity could drop as low as 10 percent of the current value. In this paper we present numerical MHD simulations of axial dipolar paleomagnetospheres with different dipole moments. We study the dipole moment dependence of the standoff distance, the polar cap size, the tail radius and compare the numerical results with the predictions of theoretical dipole scaling relations. We find that the dipole scaling relations depend on the magnitude of the southward interplanetary magnetic field (IMF) component B_z, which is not taken into account in the theoretical models. We quantify the B_z-dependence of the size of the paleomagnetosphere and compare our results with the empirical formulas obtained from in-situ satellite measurements for the present-day magnetosphere [*Roelof and Sibeck*, 1993]. Furthemore, we study the magnetosphere-ionosphere coupling in the paleomagnetosphere using the ionospheric module of the BATS-R-US MHD code. We derive the dipole moment dependence of region 1 field aligned currents and the ionospheric transpolar potential. Because of the nonlinear feedback mechanism of magnetosphere-ionosphere coupling, a power law scaling can be established only for the saturation currents and the saturation transpolar potentials. In general, we found quite good agreement between the MHD simulation results and the theoretical Hill-Siscoe [*Siscoe et al.*, 2002] model of magnetosphere-ionosphere coupling. Better fit could be obtained by a refined treatment of the IMF B_z-dependence in the Hill-Siscoe model.

References

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