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A theoretical spatial power spectrum of the Earth's lithospheric magnetic field

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The lithospheric magnetic potential can be expressed in terms of spherical harmonics parameterized with Gauss coefficients but also in terms of an equivalent layer of susceptibility values varying laterally within a shell of constant thickness. We exploit these two equivalent representations in order to propose a new theoretical expression for the spatial power spectrum of the lithospheric magnetic field for spatial scales larger than 50 km. This theoretical form depends on three parameters: the mean apparent susceptibility, the thickness of the shell, and the power law of the susceptibility power spectrum. This theoretical spatial power spectrum is compared to the NGDC-720 lithospheric magnetic field model expanded to spherical degree 720 that is derived from airborne, marine, and satellite magnetic measurements. This comparison allows us to predict a mean global apparent susceptibility of 0.03±0.01, a mean magnetic crustal thickness of 20 km ±10 km, a magnetic field root mean square of about 250 nT at the Earth's mean radius, and a power law for the apparent susceptibility ranging between -1.3 and -1.4. We then transform two independent geophysical maps, one for the world magnetic susceptibility distribution, and one for the seismic crustal thickness (the CRUST2.0 model). We find a power law equal to -1.34±0.02 with a mean value of 0.03 SI for the susceptibility model and a mean value of 21 km for the seismic crustal thickness. These values compare well with the independent theoretical analyses conducted solely on the NGDC-720 magnetic field model. This result provides us with some confidence that the theoretical form we propose is statistically consistent with the magnetic observations while being also in agreement with the putative values of some key physical parameters characterizing the sources of the lithospheric geomagnetic field.