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Geomagnetic field shielding over the past 100 000 years

Monika Korte, Jiawei Gao, and Sanja Panovska
Deutsches GeoForschungsZentrum GFZ, Potsdam, Germay, (monika@gfz-potsdam.de)

The geomagnetic field prevents energetic particles, such as galactic cosmic rays, from directly interacting with the Earth's atmosphere. The geomagnetic field is not static but constantly changing, and over the last 100,000 years several geomagnetic excursions occurred. During geomagnetic field excursions, the field strength is significantly decreased and the field morphology is controlled by non-dipole components, and more cosmic ray particles can access the Earth's atmosphere. Paleomagnetic field models provide a global view of the long-term geomagnetic field evolution, however, with individual spatial and temporal resolution. Here, we reconstruct the geomagnetic shielding effect over the last 100,000 years by calculating the geomagnetic field cutoff rigidity using four global paleomagnetic field models, i.e., GGF100k, GGFSS70, LSMOD.2, and CALS10k.2. We find that the non-dipole components of the geomagnetic field are not negligible for estimating the long-term geomagnetic shielding effect, in particular during excursions. Our results indicate that cosmic ray flux, impact area, and cosmic ray radiation intensity increase strongly during the excursions. Our results provide the possibility to accurately estimate the cosmogenic isotope production rate and cosmic radiation dose rate covering the last 100,000 years.