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Joint inversion of paleomagnetic and cosmogenic isotope data for modeling the global geomagnetic field

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The Earth's magnetic field varies on a range of spatial and temporal scales. Recent models, spanning the past 100 ka, greatly improved our knowledge of the long-term changes of the geomagnetic field, and geomagnetic excursions - events associated with strong directional deviations and low field intensities. However, these models are limited by the spatial and temporal data distribution, and magnetic and age uncertainties of underlying data. Variations in the production of cosmogenic radionuclides, such as ^{10}Be from ice cores and sediments, provide an independent proxy of paleointensity variations for a range of timescales. This study demonstrates the potential of a joint inversion of paleomagnetic data with cosmogenic nuclide production rates to reconstruct the geomagnetic field evolution over the past 70 ka. Here, we present a global compilation of ^{10}Be records, converted to magnetic field intensity, and compare them to paleomagnetic sediment records. General trends of the virtual axial dipole moment (VADM) stacks derived from the two data sets agree well. Two models have been constructed: GGFSS70-10Be where the converted ^{10}Be records are used similarly to the paleomagnetic records, and GGFSS70-10Be-DIP where the converted ^{10}Be data have been considered to be a function of the dipole only (the first three Gauss coefficients). These models are compared to the previously published GGFSS70 model based on paleomagnetic data only. Geomagnetic excursions are reconstructed in the multi-proxy models: the most pronounced Laschamps event (41 ka) and a few other excursional signatures at the times of the Norwegian-Greenland Sea and Mono Lake/Auckland excursions. Model predictions and global field maps show that the cosmogenic isotope records have regional effects on the reconstructed variations (Greenland, South/Southern Ocean, east-equatorial Pacific), especially those with high resolution (Greenland ice cores). The ^{10}Be records not only provide an independent source of information on the geomagnetic field, thus confirming the reliability of the paleomagnetic records, they also improve the global geomagnetic field reconstructions over long timescales.