From Cosmic Explosions to Terrestrial Fires? A Reply

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Deschamps and Mottez (2020) argue that the Gauss-Matuyama magnetic field reversal at the Pliocene-Pleistocene boundary would have greatly lowered the overall ability of Earth's magnetic field for a time order of 10^4 years, allowing many more cosmic rays to reach Earth's atmosphere and surface. Deschamps and Mottez argue that this would enhance the effect we proposed in Melott and Thomas (2019).

This argument is valid for most of the cosmic rays Earth receives today, which are below a billion (10^9) eV (1 GeV) in energy. These cosmic rays mostly affect only the upper atmosphere directly. However, as shown in figures 2 and 3 of our article, the inputs from nearby supernovae have energies up to a million times greater. Earth's magnetic field is only effective for particles with rigidity below about 20 GV (Smart and Shea 2009); for protons, this energy is roughly 20 GeV, well below the energies to which our modeled supernova cosmic rays extend. This limited rigidity is the basis of their ability to penetrate to the troposphere and ionize it and, thus, is the basis of our hypothesis on the great increase of cloud-to-ground lightning. But because such cosmic rays are almost not at all deflected by Earth's magnetic field, they would not be measurably enhanced by a magnetic field reversal. Ionization of the stratosphere and ozone depletion is possible by the cosmic rays deflected by the terrestrial magnetic field and might be slightly enhanced by the reversal.

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