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The atmospheric ionization rate estimation during solar proton events

A cosmic ray flux, predominantly protons, is continuously present at the boundary of both the Earth's magnetosphere and atmosphere, and can be divided into galactic cosmic rays (GCR) and solar cosmic rays (SCR). While the GCR flux is isotropic and its proton spectrum has a wide energy range, the characteristics of SCR depend on solar activity, and their energies rarely exceed a few GeV. Nevertheless, the absolute flux unit of SCR can significantly surpass that of GCR (by several orders). Both GCR and SCR primary protons, depending on their energy, can reach the upper boundary of the Earth's atmosphere (conventionally set at 100 km in this study) and interact with atmospheric nuclei (mainly oxygen and nitrogen). In this work, the propagation of cosmic ray protons through the Earth's atmosphere is modeled using a own program based on the GEANT4 SDK. Examples of altitude ionization profiles are presented for various values of vertical geomagnetic cutoff rigidity and for different primary cosmic ray proton spectra.

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