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Cosmic Ray Induced Ionization in the Atmosphere: An Improved Model

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We present a full quantitative physical model to calculate cosmic ray induced ionization in the atmosphere. The model is based on the Monte-Carlo CORSIKA tool, which simulates full development of an electromagnetic-muon-nucleonic cascade in the atmosphere, with the FLUKA package used for low energy interactions. The direct ionization by primary cosmic rays is explicitly taken into account. The model is applicable to the entire atmosphere, from the ground up to the stratosphere. A comparison to direct measurements of the ionization in the atmosphere confirms the validity of the model in the whole range of geographical latitudes and altitudes. This provides a new tool for a quantitative study of the space weather influence upon the Earth's environment. We apply the model to study the cosmic ray induced ionization on different time scales. In particular, variations of the induced ionization are calculated for the last centuries and show a great variability, about 50% between the modern period and the Maunder minimum.