

Cosmic Rays and Their Connection to Space Weather and Earth's Climate

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Abstract: Cosmic rays have been studied for over a century. In addition to investigating their fundamental properties, such as origin, composition, and acceleration mechanisms, some of the most important studies in the field involve the interaction of cosmic rays within the heliosphere, near-Earth space, and the immediate Earth's environment. These areas have been of particular interest in recent years.

One such type of study focuses on the modulation of cosmic rays by the solar magnetic field and the geomagnetic field in the heliosphere and Earth's magnetosphere, respectively. Among other things, the study of these modulations allows for the indirect observation of solar events, which produce characteristic signatures in the interplanetary magnetic field.

Another interesting aspect of cosmic ray physics involves the interactions of secondary cosmic rays, primarily the muon component, within Earth's atmosphere. Precise models of these interactions allow for corrections for atmospheric effects to be made to the muon flux, increasing the sensitivity of Earth-based detectors. Additionally, these models can enable inverse

diagnostics of the atmosphere, potentially providing an additional technique for atmospheric sounding.

Thus, precise monitoring of cosmic ray variations can serve as a proxy for measuring solar activity and variations in Earth's atmosphere. This can be invaluable in situations where direct measurements are not available and can provide significant contributions to the study of space weather and Earth's climate.

Keywords: cosmic rays, solar physics, atmospheric effects, space weather, Earth climate