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Implications of the Temperature Effect Analysis Using Simulated Secondary Cosmic Muon Data

Savić, M.R.,[1] Veselinović, N.B.,[1] Dragić, A.L.,[1] Maletić, D.M.,[1] Joković, D.R.,[1] Banjanac, R.M.,[1] Knežević, D.,[1] Travar, M.[1] and Udovičić, V.I.[1]

[1]*Institute of Physics Belgrade, Pregrevica 118, 11080 Belgrade, Serbia*
E-mail: msavic@ipb.ac.rs

As it propagates through the atmosphere, the muon component of secondary cosmic rays is influenced by variations in atmospheric parameters. The two most significant atmospheric effects affecting the muon flux detected at ground level are the barometric effect, due to changes in atmospheric pressure, and the temperature effect, caused by fluctuations in atmospheric temperature.

To enhance the sensitivity of ground-based muon detectors to cosmic ray variations of non-atmospheric origin, these effects must be corrected, with the temperature effect being more complex to model. The most well-established method for correcting the temperature effect is the integral method, based on the theory of atmospheric effects (Dorman 2004). However, as it is not so straightforward to implement, several empirical methods have been developed over the years, including the effective level of generation method (Duperier 1949), the mass-averaged temperature method (Dvornikov et al. 1976), as well as more recent approaches based on principal component analysis (Savić et al. 2019) and machine learning applications (Savić et al. 2021).

Each theoretical and empirical approach has its advantages and limitations, and directly comparing the effectiveness of these methods with real measured data is not necessarily simple. One way to address this is to test model performance on simulated data, where atmospheric variation is the only source of flux change. Preliminary results from data simulated with the CORSIKA package (Heck et al. 1998) provide a clearer picture of the strengths and limitations of these methods. Specifically, the results suggest that the integral method may lead to overcorrections if applied too directly, an issue that hadn't been that obvious before.

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