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[Abstract]

Atmospheric Effects on Secondary Cosmic Ray Muons: A Comparison Between Simulation and Observations

Mihailo Savić[1], Nikola Veselinović[1], Aleksandar Dragić[1], Dimitrije Maletić[1], Dejan Joković[1], Radomir Banjanac[1], Vladimir Udovičić[1]

[1]Institute of Physics Belgrade, National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia,
ORCID number: 0000-0003-4368-0248,
ORCID number: 0000-0003-3373-2104,
ORCID number: 0000-0001-6934-0095,
ORCID number: 0000-0002-9163-6703,
ORCID number: 0000-0002-3404-2706,
ORCID number: 0009-0002-9883-8129,
ORCID number: 0000-0002-7839-1537

[*]Correspondence: msavic@ipb.ac.rs

Abstract: The propagation of cosmic-ray muons through the atmosphere is strongly influenced by changing atmospheric conditions. Accurately modeling these effects requires considering the entire atmospheric profile. Correlations can arise not only between different atmospheric parameters but also within the same parameter across multiple atmospheric layers. As a result, disentangling the precise contributions of these effects is nontrivial, particularly when using empirical correction models (Dorman 2004).

To address this, we employed the CORSIKA Monte Carlo package (Heck et al. 1998) to simulate muon count rate time series in which all observed variations originate solely from changes in atmospheric conditions. Our focus was on assessing how well the two dominant effects, the barometric effect (linked to variations in atmospheric

pressure) and the temperature effect (caused by atmospheric temperature fluctuations) are represented in the simulated data. For this purpose, we applied standard correction procedures (Savic et al. 2016) to both simulated and real muon flux datasets and compared the resulting time series.

The analysis showed that the annual variation in the simulated data is effectively removed after temperature correction, suggesting that CORSIKA most likely models the temperature effect with good accuracy. In contrast, the significant residual variations that remains after both barometric and temperature corrections could indicate potential issues in the way the barometric effect is implemented in the simulation framework. This result highlights the importance of carefully evaluating the accuracy of atmospheric corrections in simulations before applying them as benchmarks for empirical or theoretical models.

Keywords: [Cosmic rays, muons, atmospheric effects, CORSIKA]

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