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Comparison of the atmospheric muon flux in KM3NeT data with simulations using the data-driven Daemonflux model

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Muons, created by the interactions of cosmic rays with the Earth's atmosphere, form the main component of the cosmic ray air showers which reach underwater or in-ice detectors such as KM3NeT and IceCube. Precise measurements of such muons can provide key insights into the properties of cosmic rays, and their interactions. The KM3NeT research infrastructure consists of two telescopes in the Mediterranean Sea, KM3NeT/ORCA, deployed at a depth of 2450 m off the coast of Toulon, France, and KM3NeT/ARCA, deployed at a depth of 3500 m offshore Capo Passero, Italy. This design provides a unique opportunity to measure the flux of atmospheric muons at two depths and locations. Exploiting this feature, the KM3NeT collaboration recently reported a comparison of the atmospheric muon flux between the data collected using six lines of KM3NeT/ORCA and six lines of KM3NeT/ARCA and simulations performed using CORSIKA. These Monte Carlo simulations are found to be significantly underestimating the event rates with respect to data, thus contributing to the phenomenon called the Muon Puzzle. In an attempt to resolve the global Muon Puzzle, a data-driven model has been developed to describe the atmospheric muon flux at sea level. In this study, the Daemonflux model is incorporated into the KM3NeT simulations. A significant improvement has been observed in the comparison between these simulations and the data collected using 21 lines of KM3NeT/ARCA and 13 lines of KM3NeT/ORCA. Furthermore, we also show a significant reduction in the systematic uncertainties on the simulations.

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