Dear,

Editorial support team
Copernicus Publications

Referee report of the manuscript gi-2024-4 (**Distance of flight of cosmic-ray muons to study dynamics of the upper muosphere**).

The paper presents the concept of muosphere as the region where a high concentration of muons and its limit respectively. It describes muosphere/muopause dynamics depending on crustal density (millennia time order) or isobaric surface height variations. The author introduces the DoF (Distance of Flight) technique for characterizing the muosphere based on measured data of the muon flux. The paper describes in detail the modeling process and compares it with measured data.

The technique is interesting but its application in a concrete problem isn't obvious. It's important to extend this technique in a real scenario and contrast it conceptually with techniques (like LIDAR) that can perform the same work. I recommend publishing the paper after adding the modifications listed below.

line 49. The muosphere is defined from +10 km to -10 km, however in the equation at line 55 the muosphere thickness is 3.5×10^4 m.

line 54. Typo in $1.6 \times 10^2 m^{-2} s^{-1}$.

line 53. The estimated muon abundance is $\sim 8 \times 10^{12}$ muons, however solving the equation is $\sim 9.3 \times 10^{12}$ muons. I recommend to put the equation out from the text.

line 53. In the muon abundance equation a constant integral muon flux is used, this flux is the one measured at sea level, but not the same underground where the muon flux significantly decreases. Does it affect the abundance calculation?

line 72. The author establishes that study of muopause dynamics contribute to the research field and mention some cases. Could you describe, in more detail, how the parameterization of the muosphere/muopause can contribute?

line 95. Some reports on the study of barometric and temperature effects in the muon flux are mentioned. The Pierre Auger Observatory has made studies on the influence of atmospheric pressure/temperature (using meteorological balloons) in cosmic ray flux, it's important to cite them. J. Blumer et al. Atmospheric Profiles at the Southern Pierre Auger Observatory and their Relevance to Air Shower Measurement. 2005.

line 102. The author set three major identified characteristics, but only A and B are described, is there a C?

Figure 2. The scale of the muon flux variation is not clear in the panel A. Was equation 1 obtained form panel-B plot on Figure 2?

Figure 3. It's important to add error bars to the plots A and B due to they are based on data.

Figure 4. The number label on the left of the blue line is missing.

Figure 5. It's valuable to add the line legend to both plots. The plot description is split into two different pages and it makes the figure reading difficult.

Figure 5. Why does the curve behave different at 90° zenith? isn't expected to follow the same trend than for the other zenith angles?

line 246. If the zenith angle is close to zero the equation diverges, so "the spherical curvature of the Earth has to be considered (for $\theta = 90°$)". Does it mean that the angle dependence is taken into account only for $\theta = 90°$?

Figure 6. Add error bars to plots contained in Figure 6.

line 270. The zenith-angle integration range was set to be $50° - 80°$. Why?

line 294. Typo, a dot is missing. (. Three PSDs ...)

line 295. In the apparatus description, the author says that between detection layers two absorbing layers are set (10-cm thick lead block and a 3-cm thick stainless-steel), if you have 10 cm of lead, is it necessary to have 3 cm of stainless-steel? why?

line 296. Typo. "10-cm thick lead block and a 3-cm thick stainless-steel with a thickness of **3 cm**".

line 240. Write properly equation 2-2. It's confusing.

Equation 2-2. What is the meaning of the constant 660? where does it come from?

Equation 1. The relationship between atmospheric pressure and muon flux is inverse, in that way, isn't the slope of equation 1 negative?