Comparison Between CAPRICE98 Atmospheric Muon Data and Simulations with TARGET

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Abstract

On 28 May 1998 the balloon-borne experiment CAPRICE98 was launched from Fort Sumner, New Mexico. During the three hour ascent to float altitude it recorded both positive and negative muon data in a wide momentum range from 0.3 to 20 GeV/c. We simulate the muon fluxes in several altitude bins and at ground level (885 g/cm^2) with the 3D interaction code TARGET. This code accounts for the muon deflection in the geomagnetic field at Fort Sumner. As input for the simulation it employs the primary proton and He spectra measured by the experiment itself, thus reducing the systematic experimental uncertainties related to the absolute flux calculations.

1. Introduction

Calculations of the atmospheric lepton fluxes need two different sets of inputs: the primary cosmic ray flux at the time of the measurement and a hadronic interaction code that describes correctly the interaction properties in the whole phase space. The uncertainties in these two sets of input determine the uncertainty in the calculated fluxes.

We make an attempt to decrease the uncertainties by using primary cosmic ray and secondary muon fluxes measured by the same instrument in the same flight [1,2]. In addition to the H and He fluxes measured by CAPRICE98 in 1998 we use the parametrization of the fluxes of heavy nuclei [3] presented at the Hamburg conference. The all nucleon flux obtained in this way is shown in Fig. 1 in comparison to other fluxes used in calculations of atmospheric leptons.

The inclusion of nucleons from heavy nuclei make the CA98 flux model better than the formerly used [4] CA94 flux model that included only the H and He contribution. It is still, however, significantly lower than the models of

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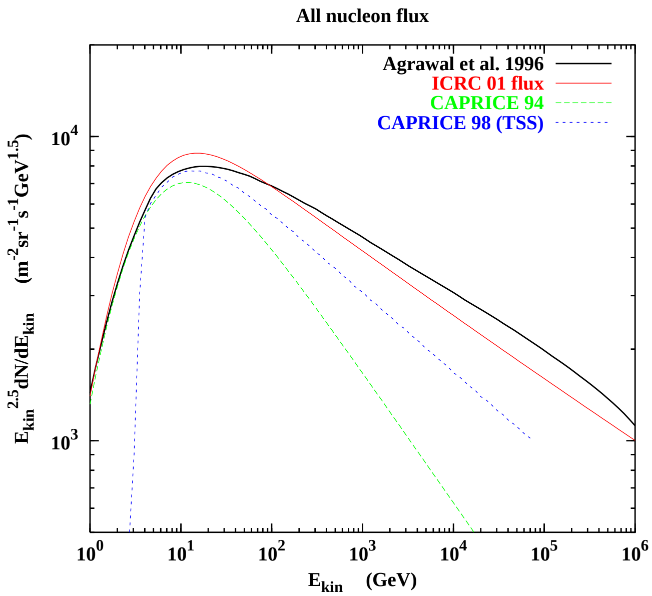

Fig. 1. Comparison of the all nucleon flux used in this calculation with other cosmic ray flux models.

Refs. [3,5] at high energy. This is however relatively unimportant for the flux of muons of momentum below 20 GeV/c measured by CAPRICE98.

2. Some results of the simulation

We were not able to complete the whole set of simulations on time to include it in this paper. For this reason we only compare the experimental results to simulated spectra in three of the higher altitude measurements in Fig. 2.

Muon fluxes at float altitude (5.5 g/cm^2) were not well enough measured and are not shown, although the agreement with the two measured data points is good. At 48.4 g/cm^2 the fluxes of positive muons are predicted well, but the negative muon fluxes are underpredicted. Some of the differences may be due to the rough treatment of the muon momentum spectra in the figure, which assumes that the average muon momentum is the geometric mean for the bin.

Another assumption that may have some influence is that all muons are detected at the average altitude. A better comparison should account for the altitude dependence of the muon flux in different momentum intervals.

The good agreement of the calculation with the measured fluxes is encouraging. The altitude of 165 g/cm^2 is close to the maximum production depth for GeV muons and suggests that the representation of the hadronic interactions in the energy range up to 200 GeV is very reasonable.

The steeper primary energy spectrum does not affect the muon flux predictions at high altitude, but it may show up in the prediction of the muon fluxes

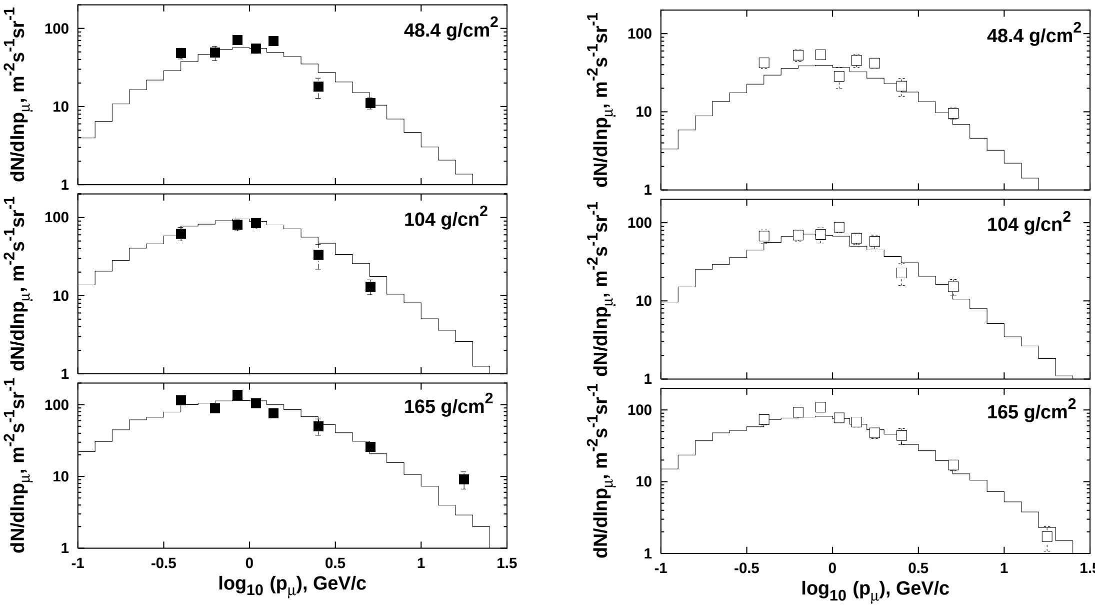

Fig. 2. Comparison of the calculated with detected muon fluxes at three relatively high altitudes. Lefthand panel: positive muons, righthand panel: negative muons.

at ground level.

At the Conference we will compare the full set of predictions with the CAPRICE98 muon data and will discuss the development of the muon flux in the atmosphere and the effects of the magnetic field on it.

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3. References

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