ALTITUDE VARIATIONS OF COSMIC-RAY SOFT AND HARD COMPONENTS OBSERVED BY AIRBORNE DETECTORS

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ABSTRACT

The altitude variations of cosmic-ray total and hard components were measured upto 12,000 m on voard a jet liner over Japan island on December ,1981. Observed results together with soft component arepresented conpa-ring with the model calculations through the atmosphere by applying the hardronic cascade.

1. Introduction

Since last two air-borne experiments(1979,1981), the altitude and latitude variation of various components of cosmic rays have been analyzed from various points of view (1),(2). In the analyses, we showed that our results did not contradict with Rossi's (3). And the model calculations through the atmosphere by applying the hadronic cascades were compared with the observed results (4),(5).

We used telescopes composed of two plastic scintillators of thickness of 3 cm ,of which geometric factor was 96 $cm^2 sr$(6).

2. Altitude variation of vertical intesity of hard component

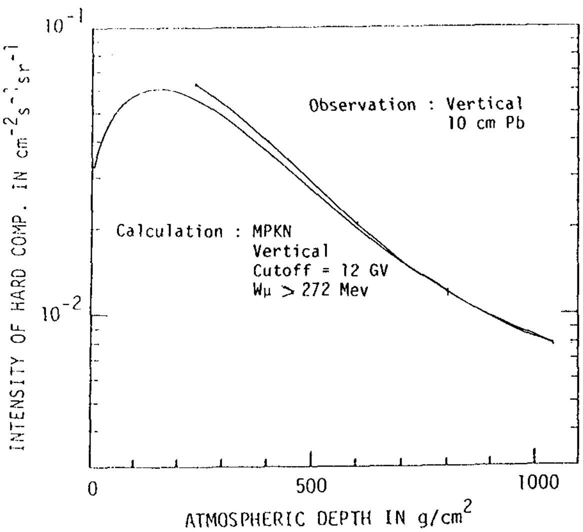

Fig. 1. The observed and calculated integral growth curves of hard components. The calculated curve shows the total of intensities of muons, pions, kaons, and protons. The observation curve is obtained by means of the weighted best fit of the data in 1981.

In Fig. 1 are included the altitude variations of hard component for vertical. The obserbation curve is obtained by means of the weighted best fit of the 41 data points with regard to 4 level flights at the depths of 221, 243, 560, and 1038 g/cm^2, including the ascending and the descending.

The calculation curve represents the total of intensities of muons, pions, kaons, and protons with threshold energies of 273, 315, 751, and 1260 MeV respectively, at cutoff rigidity of 12 GV.

At the smaller atmospheric depth, it seems that the slight discrepancy exists between the observed and the calculated curve because the observation curve contains some components with high energy other than the calclated four components.

3. Analysis of the total, hard and soft components

In Fig. 2, curve(T) represents the total component measured without lead absorber. The observed total component contains the electronic component of electrons and photons other than the calculated total(H') of muons, pions, kaons,and protons without lead absorber. Curve(H) is the obserbed hard component capable of penetrating 10 cm lead absorber. Curve(S) represents the soft component which are stopped by 10 cm lead, that is to say (S) is the difference between (T) and (H).

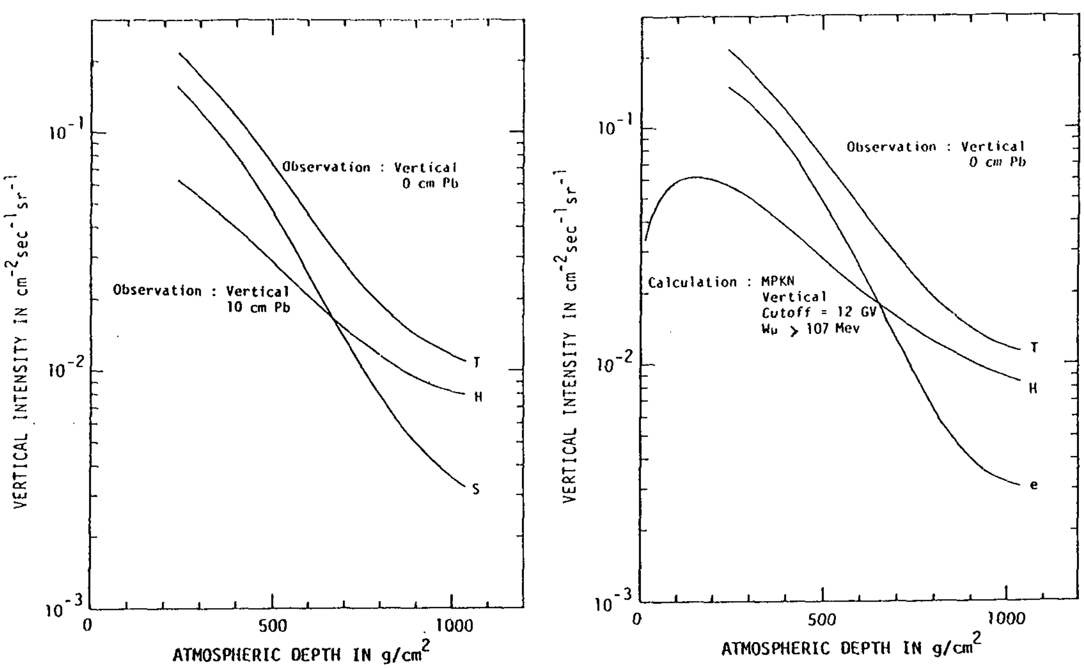

Fig. 2. The vertical intensities of the observed total component(T), of the observed hardcomponent(H), of the soft component(S), of the calculated total like in Fig. 1 (H'), of the (T)-(H') component(e) as a function of atmospheric depth.

We obtained the attenuation curves against the thickness of lead absorber at different altitudes for the vertical component (1979) (1). It is shown in the report that the curves are steeper for smaller thickness than 10 cm of lead and flatter for large thickness. It seems that this is due to the existance of electrons which are easily absorbable.

From what descrived above, we may say that the difference between (T) and (H'), namely (e) represents the electronic component. The energy of electrons are greater than nearly 10 MeV.

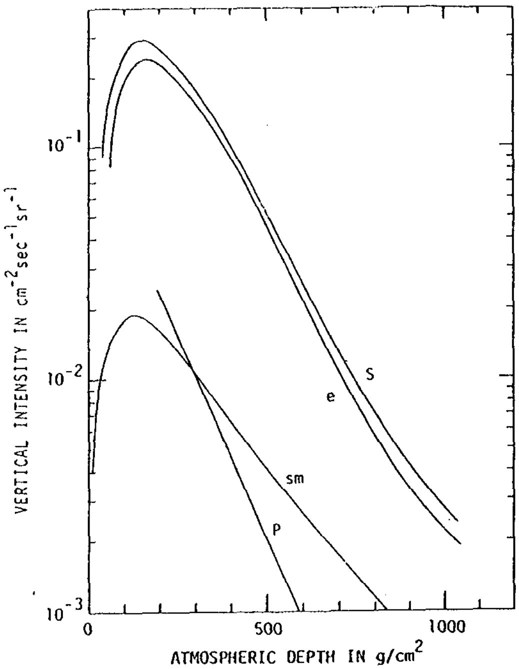

Fig. 3. Analysis of the soft component by B.Rossi. The curves represent vertical intensities as a function of atmospheric depth for slow mesons with momenta smaller than $3\cdot10^8$ eV/c (sm), proton (or other charged N-rays) with momenta between $4\cdot10^8$ eV/c and 10^9 eV/c (p), electrons of practically all energies above 10^7 eV (e).

Fig. 3 shows analysis of the soft component by B.Rossi (3). At small depth, there are enhancements of (s) and (e) by Rossi compared with ours. It may be caused by a enhancement of low energy electron at high latitude greater than 45°.

At atmospheric depth of 600 g/cm^2, the attenustion meanfree pathes for (s) and (e) by Rossi and us are nearly equal to 140 g/cm^2.

As mentioned above, it seems that the total,hard,soft,and electronic components are able to be explained by means of combining the observed result with the calculated one.

Reference

(1). Takahashi, K. (1979) Conf. Papers 16th ICPC, 4, 342.
(2). Takahashi, K. et al. (1983) Conf. Papers 18th ICRC, 10, 218.
(3). Rossi,B. (1948) Rev. Mod. Phys., 20, 537-583.
(4). Murakami, K. et al. (1979) Nuovo Cimento 2C, 635.
(5). Murakami, K. et al. (1981) Rep. CRRL, Cosmic-Ray Res. Lab. Nagoya Univ. No. 6.
(6). Takeuch, H. (1982) Sci. Papers IPCR, 75, 1.