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The monitoring of atmospheric pressure variations by neutron monitor data.

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Abstract. There was an attempt to define an atmospheric pressure change on the basis of multi-channel registration of the cosmic rays with neutron monitor SKL «Novosibirsk». As an example the Forbush decrease of March 1991 was taken. The use of the results of CR multi-channel record with the help of monitor enables to value the atmospheric pressure changes.

1 Introduction

While processing the results of the ground observation of the cosmic rays (CR) the variations of the atmospheric origin are taken into account by means of amendments to the initial data of measurements Dorman (1972). The atmospheric variations of the neutron component recorded by the network of neutron monitors are brought mainly to the barometric effect Dorman (1972). In case of recording of multiplicity of local generation neutrons the monitor changes into a multi channel device the channels of which have different connection coefficient as well as different barometric coefficient Yanchukovsky at al. (1995). The possibilities of multi-channel registration of the CR with neutron monitor were shown by Forbush decrease of the CR analysis Yanchukovsky at al. (2000). The barometric effect was taken into account in the initial data of the observations. The barometric coefficients were defined by correlation of CR intensity in each channel and atmospheric pressure as well as by the results of high-altitude measurement Yanchukovsky at al. (1997). The attempt to use the multi channel data of CR variations without correction on barometric effect that should be defined by the system of equation of CR variations is given below.

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2 Method of pressure definition

The intensity variations $\Delta I(n)/I(n)$, recorded in n channels of a monitor are represented as

$$\frac{\Delta I(n)}{I(n)} = \frac{1}{\alpha(n)}\int_{R_C}^{\infty} \frac{\Delta D(R)}{D(R)} V(n,R)dR - \Delta R_C V(n,R_C) + \\ + \{\exp[-(h-h_0)\beta(n,h-h_0)]-1\}. \quad (1)$$

Here, as in Yanchukovsky (2000), $\alpha(n)$ - is normalization coefficient; $V(n, R)$ - are normalized connection coefficients with rigidity of cut-off R_C; $\Delta D(R)/D(R)$ - is primary rigidity spectrum of CR variations, that is taken as $BR^{-\gamma}$; $\beta(n,h\text{-}h_0)$ - are barometric coefficients for channels n of monitor, which we show Yanchukovsky at al. (1997) as depending on $F(n)$ (from experiment), here $F(n)$ is ratio of thresholds of channels n and $n=1$, and change of atmospheric pressure (h-h_o):

$$\beta(n,h-h_0) = \frac{\beta_0(h-h_0)F^{-c}(n)}{A(h-h_0)F(n)+B(h-h_0)} \quad (2)$$

Here

$$\beta_0(h-h_0) = N\cdot[e^{\alpha_1(h-h_0)} - e^{\alpha_2(h-h_0)}] + S\,, \quad (3)$$

$$A(h-h_0) = k - m\cdot[e^{\alpha_1(h-h_0)} - e^{\alpha_2(h-h_0)}]\,, \quad (4)$$

$$B(h-h_0) = t + m\cdot[e^{\alpha_1(h-h_0)} - e^{\alpha_2(h-h_0)}]\,; \quad (5)$$

here h_0 = 995 mbar (for SKL «Novosibirsk»); N = 1.842×10^{-3} mbar^{-1}; S = 7.05×10^{-3} mbar^{-1}; α_1 = 1.852×10^{-3}

mbar^{-1}; α_2 = 4.628×10 $^{-3}$ mbar^{-1}; m = 0.3233; k = 0.2058; t = 0.7754.The dependence of quantity of barometric effect from channel is represented as

$$\frac{\Delta I}{I}(h) = P(h)[1 - rF(n)] \quad (6)$$

here: r = 0.3086.For convenience we introduce the symbols $\frac{\Delta I(n)}{I(n)} = J_n$, $\int_{R_c}^{\infty} R^{-\gamma} V(n,R)dR = A_n$, $V(n,R_c) = V_n$. In accordance with introduced symbols we write the expression (1) as

$$J_n = B \times A_n - \Delta R_c \times V_n + P(1 - rF_n) \quad (7)$$

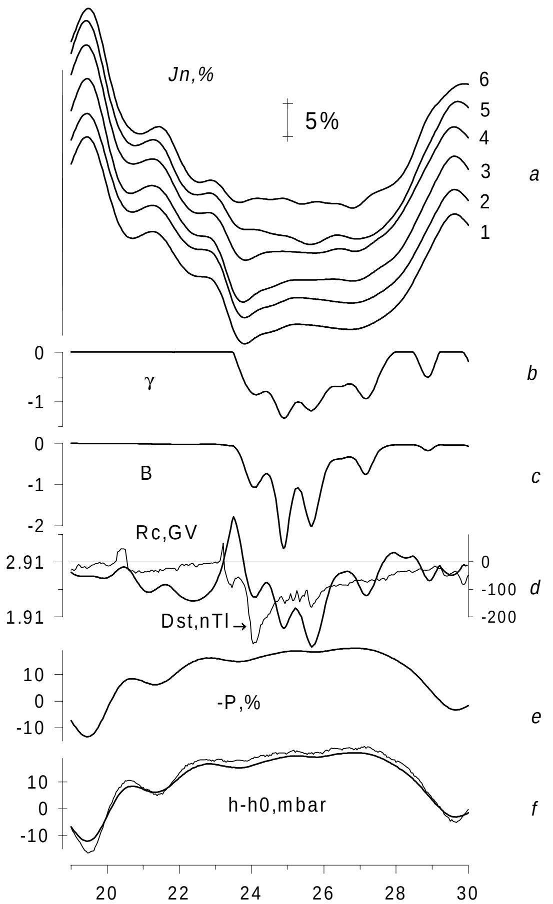

Fig. 1. Forbush decrease of March 1991.

A collection of standard subprograms is used to solve the equations (7). But the errors of matrix coefficients and left part and round off error can deform the solution. For this reason a discrepancy regulation method for poor attributed system was used Kalitkin (1978). The discrepancy should be compared with the experimental data error.

$$C \cdot \sigma_n \approx \left\| J_n^{\exp} - J_n \right\| \quad (8)$$

here: C - is a regulation coefficient (C>0),σ_n - is data error, $J_n^{\exp}$ - are the observed values. The sum of squares of discrepancies

$$\sum_n [\left\| J_n^{\exp} - J_n \right\| - C\sigma_n]^2 = f(\gamma, \Delta R, B, P)$$

are the function of four variables. The solution comes from the condition when the first quotient derivatives are equal to zero and the second derivative is more than zero.

3 Discussion

As an example the Forbush decrease of March 1991 was taken. The results are given in *fig.1*, where the initial data of the recorded intensity of the first six channels (fig.*1a*) is represented (the channel number is shown by the figures at curves). The results were smoothed over with the glancing mean and have no pressure correction; the parameters of the spectrum of the primary variations γ and B are given in (fig. *1b* and *1c* accordingly); the change of rigidity of geomagnetic cut-off and Dst-index in (fig.1d); parameter P (fig.*1e*) characterizes the barometric effect; atmospheric pressure change is given in (fig.1f). Figure *1f* shows the atmospheric pressure changes measured with digital barograph (thin line) and thick line shows the pressure changes received by calculation.

The use of the results of CR multi-channel record with the help of monitor enables to value the atmospheric pressure changes. With the growth of the recorded multiplicity of local generation *n* neutrons in monitor the barometric effect increases. At the same time the statistic errors of hourly values grows sharply. For this reason the initial data was smoothed over. As a result there is some difference between measured and calculated values.

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