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Determination of Barometric Coefficients for Total Neutron Intensity and Neutron Multiplicities on the base of Emilio Segre' Observatory Data Corrected for Primary Variations According to Rome Neutron Monitor Data

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Abstract

By the barometric coefficients determined in a first approximation in the way from sea level to the place of stationary operation, we corrected for barometric effect the total neutron intensity and intensities of neutron multiplicities detected by a 6NM-64 neutron monitor installed inside the Emilio Segre′ Israelo-Italian moving laboratory (Mt. Hermon, Israel, 2020 *m* a.s.l.). The period June-December 1998 was analysed. We compared the obtained results with the Rome 17NM-64 neutron monitor data and corrected the Emilio Segre′ Observatory data for primary variations. We determined with high accuracy barometric coefficients for the total neutron monitor counting rate and for the intensities of detected neutron multiplicities m=1, m=2, m=3, m=4, m=5, m=6, m=7 and $m \geq 8$.

1 Introduction:

In Dorman et al. (1999) we found in a first approximation the attenuation coefficients between levels 760 *mm*Hg, 626 *mm*Hg and 598 *mm*Hg by the altitude dependencies of total neutron intensity and neutron multiplicities. We will use here attenuation coefficients between levels 626 *mm*Hg and 598 *mm*Hg for the correction of our data for barometric effect (see Table 1).

Table 1: Attenuation coefficients (in units $(mm\mathrm{Hg})^{-1}$) between levels 626 *mm*Hg and 598 *mm*Hg

TOTAL	m=1	m=2	m=3	m=4	m=5	m=6	m=7
0.00886	0.00707	0.00950	0.01097	0.01106	0.01197	0.01192	0.01201

By these attenuation coefficients we corrected cosmic ray data of observations for the period June-December 1998 and we correlated the obtained results with Rome data corrected for barometric effect. By the obtained regression coefficients we corrected our original data for cosmic ray primary variations. We correlated the corrected data with air barometric pressure and determined second approximation barometric coefficients. Then, we corrected our data for barometric effect with much better accuracy and we correlated the new intensity data with the Rome data. By the new regression coefficients we could apply more precise corrections for primary variation on the cosmic ray Emilio Segre' Observatory data. Then, we determined third approximation barometric coefficients.

2 Barometric Coefficient for Total Neutron Monitor Counting Rate:

We used hourly data (obtained from one-minute data) for a total of 3979 hours of measurements in June-December 1998. After correction of total intensity I_{ESO}^{tot} for barometric effect with attenuation coefficient $\beta_{tot}^{(1)}$ according to Table 1 (first column) and correlation with Rome neutron monitor total intensity I_{Rome}^{tot} corrected for barometric effect, we obtained the regression

$$\ln\left(I_{ESO}^{tot}, \text{ corrected with } \beta_{tot}^{(1)}\right) = (0.6147 \pm 0.0097) \times \ln\left(I_{Rome}^{tot}\right) + Const \quad (1)$$

with correlation coefficient $r = 0.7150 \pm 0.0075$. After correction for primary variations according to Rome data with regression coefficient $\alpha_{tot}^{(1)} = 0.6147 \pm 0.0097$ and correlation with air pressure data, we obtained the second approximation barometric coefficient

$$\beta_{tot}^{(2)} = -(0.009222 \pm 0.000053)\ (mm\ \text{Hg})^{-1} \quad (2)$$

with correlation coefficient $r = -0.9418 \pm 0.0036$. To obtain third approximation coefficient we determined

$$\ln\left(I_{ESO}^{tot}, \text{ corrected with } \beta_{tot}^{(2)}\right) = (0.6331 \pm 0.0096) \times \ln\left(I_{Rome}^{tot}\right) + Const \quad (3)$$

with correlation coefficient $r = 0.7274 \pm 0.0074$. After correction for primary variations according to Rome data with regression coefficient $\alpha_{tot}^{(2)} = 0.6331 \pm 0.0096$ and correlation with air pressure data we obtained the third approximation barometric coefficient

$$\beta_{tot}^{(3)} = -(0.009251 \pm 0.000053)\ (mm\ \text{Hg})^{-1} \quad (4)$$

with correlation coefficient $r = -0.9422 \pm 0.0036$. From comparison between (2) and (4) it can be seen that the difference between $\beta_{tot}^{(2)}$ and $\beta_{tot}^{(3)}$ is negligible within the statistical errors. Therefore, for neutron multiplicities we determined only second approximation barometric coefficients.

3 Barometric Coefficient for Multiplicity 1:

In this case instead of (1) we obtain

$$\ln\left(I_{ESO}^{1}, \text{ corrected with } \beta_{1}^{(1)}\right) = (0.5409 \pm 0.0097) \times \ln\left(I_{Rome}^{tot}\right) + Const \quad (5)$$

with correlation coefficient $r = 0.6671 \pm 0.0080$. Then, as in Section 2, we obtain

$$\beta_{1}^{(2)} = -(0.007276 \pm 0.000054)(mm\ \text{Hg})^{-1} \quad (6)$$

with correlation coefficient $r = -0.9096 \pm 0.0045$.

4 Barometric Coefficient for Multiplicity 2:

In this case we obtain

$$\ln\left(I_{ESO}^{2}, \text{ corrected with } \beta_{2}^{(1)}\right) = (0.729 \pm 0.010) \times \ln\left(I_{Rome}^{tot}\right) + Const \quad (7)$$

with correlation coefficient $r = 0.7472 \pm 0.0071$. Then,

$$\beta_{2}^{(2)} = -(0.009760 \pm 0.000058)(mm\ \text{Hg})^{-1} \quad (8)$$

with correlation coefficient $r = -0.9391 \pm 0.0037$.

5 Barometric Coefficient for Multiplicity 3:

In this case we obtain

$$\ln\left(I_{ESO}^{3}, \text{ corrected with } \beta_{3}^{(1)}\right) = (0.758 \pm 0.013) \times \ln\left(I_{Rome}^{tot}\right) + Const \quad (9)$$

with correlation coefficient $r = 0.6767 \pm 0.0079$. Then,

$$\beta_3^{(2)} = -(0.01098 \pm 0.00073)(mm \ \text{Hg})^{-1} \quad (10)$$

with correlation coefficient $r = -0.9240 \pm 0.0041$.

6 Barometric Coefficient for Multiplicity 4:

In this case we obtain

$$\ln\left(I_{ESO}^{4}, \text{ corrected with } \beta_4^{(1)}\right) = (0.702 \pm 0.018) \times \ln\left(I_{Rome}^{tot}\right) + Const \quad (11)$$

with correlation coefficient $r = 0.5227 \pm 0.0092$. Then,

$$\beta_4^{(2)} = -(0.01182 \pm 0.00010)(mm \ \text{Hg})^{-1} \quad (12)$$

with correlation coefficient $r = -0.8834 \pm 0.0050$.

7 Barometric Coefficient for Multiplicity 5:

In this case we obtain

$$\ln\left(I_{ESO}^{5}, \text{ corrected with } \beta_5^{(1)}\right) = (0.649 \pm 0.026) \times \ln\left(I_{Rome}^{tot}\right) + Const \quad (13)$$

with correlation coefficient $r = 0.378 \pm 0.010$. Then,

$$\beta_5^{(2)} = -(0.01258 \pm 0.00014)(mm \ \text{Hg})^{-1} \quad (14)$$

with correlation coefficient $r = -0.820 \pm 0.006$.

8 Barometric Coefficient for Multiplicity 6:

In this case we obtain

$$\ln\left(I_{ESO}^{6}, \text{ corrected with } \beta_6^{(1)}\right) = (0.537 \pm 0.036) \times \ln\left(I_{Rome}^{tot}\right) + Const. \quad (15)$$

Then,

$$\beta_6^{(2)} = -(0.01299 \pm 0.00019)(mm \ \text{Hg})^{-1} \quad (16)$$

with correlation coefficient $r = -0.7321 \pm 0.073$.

9 Barometric Coefficient for Multiplicity 7:

In this case we obtain

$$\ln\left(I_{ESO}^{7}, \text{ corrected with } \beta_7^{(1)}\right) = (0.309 \pm 0.049) \times \ln\left(I_{Rome}^{tot}\right) + Const. \quad (17)$$

Then,

$$\beta_7^{(2)} = -(0.01338 \pm 0.00027)(mm \ \text{Hg})^{-1} \quad (18)$$

with correlation coefficient $r = -0.6262 \pm 0.0084$.

10 Barometric Coefficient for Multiplicities ≥ 8:

In this case we obtain

$$\ln\left(I_{ESO}^{\geq 8}, \text{ corrected with } \beta_{\geq 8}^{(1)}\right) = (0.162 \pm 0.047) \times \ln\left(I_{Rome}^{tot}\right) + Const. \quad (19)$$

Then,

$$\beta_{\geq 8}^{(2)} = -(0.01427 \pm 0.00026)(mm \ \text{Hg})^{-1} \quad (20)$$

with correlation coefficient $r = -0.6632 \pm 0.0080$.

11 Comparison with Results for Rome Neutron Monitor:

According to Iucci et al. (1971), the barometric coefficients for Rome neutron monitor (sea level, $R_c = 6.2\ GV$, period of measurements 1967-1969), for $m=1$, $m=2$, $m \geq 4$, $m = 6+7$ and $m \geq 8$, were as following (see Figure 1):

$\beta_{Rome}^{Total} = -(0.00943 \pm 0.00008)\ (mm\ \mathrm{Hg})^{-1}$, $\beta_{Hermon}^{Total} = -(0.00925 \pm 0.00005)\ (mm\ \mathrm{Hg})^{-1}$

$\beta_{Rome}^{m=1} = -(0.0086 \pm 0.0001)\ (mm\ \mathrm{Hg})^{-1}$, $\beta_{Rome}^{m=2} = -(0.0098 \pm 0.0001)\ (mm\ \mathrm{Hg})^{-1}$,

$\beta_{Rome}^{m\geq4} = -(0.0107 \pm 0.0002)\ (mm\ \mathrm{Hg})^{-1}$, $\beta_{Rome}^{m=6+7} = -(0.0109 \pm 0.0003)\ (mm\ \mathrm{Hg})^{-1}$

$\beta_{Rome}^{m\geq8} = -(0.0118 \pm 0.0004)\ (mm\ \mathrm{Hg})^{-1}$. Let us do comparison with our results:

$\beta_1^{(2)} = -(0.007276 \pm 0.000054)(mm\ \mathrm{Hg})^{-1}$, $\beta_2^{(2)} = -(0.009760 \pm 0.000058)(mm\ \mathrm{Hg})^{-1}$,

$\beta_3^{(2)} = -(0.01098 \pm 0.00073)(mm\ \mathrm{Hg})^{-1}$, $\beta_4^{(2)} = -(0.01182 \pm 0.00010)(mm\ \mathrm{Hg})^{-1}$

$\beta_5^{(2)} = -(0.01258 \pm 0.00014)(mm\ \mathrm{Hg})^{-1}$, $\beta_6^{(2)} = -(0.01299 \pm 0.00019)(mm\ \mathrm{Hg})^{-1}$,

$\beta_7^{(2)} = -(0.01338 \pm 0.00027)(mm\ \mathrm{Hg})^{-1}$ and $\beta_{\geq8}^{(2)} = -(0.01427 \pm 0.00026)(mm\ \mathrm{Hg})^{-1}$.

For $m=1$ our value is smaller than for Rome, for $m=2$ we obtained the same barometric coefficient as for Rome, but for bigger m our values are bigger than for Rome. The obtained differences can be understood by taking into account the differences in altitudes and cut-off rigidities between the Rome neutron monitor and the Emilio Segre' Observatory (in the frame of theoretical latitude-dependence estimated by Hatton & Griffiths, 1968).

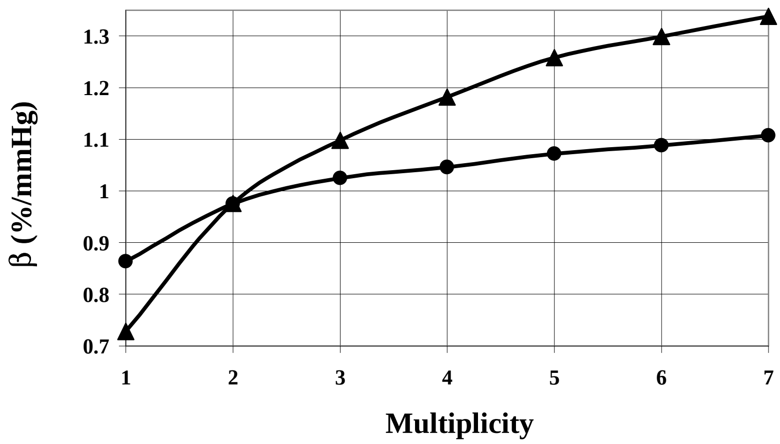

Figure 1: Barometric coefficients for Rome (•) (P_o=760 *mm*Hg, R_c=6.2 *GV*) and ESO Hermon (▲) (P_o=600 *mm*Hg, R_c=10.8*GV*)

References

Dorman, L.I. et al. Proc. 26th ICRC (Salt Lake City, 1999) Paper SH 3.6.22

Hatton, C.J. & Griffiths, W.K. 1968, J. Geophys. Res. 73, 7503

Iucci, N.et al. 1971, Nuovo Cimento 6B, No. 2, 111