Geoscientific Instrumentation Methods and Data Systems Discussions

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Reply on RC2

Maxim Philippov et al.

Author comment on "Accounting for meteorological effects in the detector of the charged component of cosmic rays" by Maxim Philippov et al., Geosci. Instrum. Method. Data Syst. Discuss., https://doi.org/10.5194/gi-2021-9-AC2, 2021

Thank you very much for your comments and suggestions! We are sure that these comments will improve the quality of the paper and allow us to optimize our work.

Response to Anonymous Referee #2

page 1, lines 14f:

The geographic coordinates of the Dolgoprudny station are not correct. Moscow is not in the South hemisphere and not in the West of the prime meridian (Greenwich). Please check. In addition, the meaning of the parameter "Rc" should be given in the text.

Response

Thank you very much for your comment and suggestion. We've corrected it in the text.

page 1, line 16:

"... barometric and temperature coefficients ..." -->

"... barometric and temperature correction coefficients ..."

page 1, line 18:

Please give information about what exactly you mean with "upper-air sounding of the atmosphere".

page 2, line 36:

I recommend to write "atmospheric pressure" instead of only "pressure".

Response

Thank you very much for your comment and suggestion. We've corrected it in the text.

page 2, lines 37ff:

"The CARPET installation detects particles of the following energies: in the UP and the LOW channels there are electrons and positrons with energies E> 200 keV, protons with E> 5 MeV, muons with E> 1.5 MeV, and photons with E> 20 keV (efficiency <1%).": Is "(efficiency <1%)" valid for all particle types or only for photons?

Response

Thank you very much for your comment and suggestion. Gas-discharge counters have some sensitivity to photons, mainly due to the Compton effect on the shells of the counter.

page 2, lines 46ff:

Please check the coordinates of the stations in this paragraph and if the effective cutoff rigidity is computed for the correct location. In addition, I would appreciate if you could give the time epoch for which Rc is given.

Response

Thank you very much for your comment and suggestion. We've corrected it in the text.

page 2, first paragraph under "2.1 Barometric effect":

I recommend to move the first paragraph starting with "Ground-based CARPET installations detect secondary charged particles, ..." under "2. Instrumentation and data analysis".

Response

Thank you very much for your comment and suggestion. We've corrected it in the text.

page 2, line 56:

What do you understand under "nuclear-active particles"?

Thank you very much for your comment and suggestion. We checked. This term is correct in English-speaking literature. For example:

https://iopscience.iop.org/article/10.1088/0305-4470/7/6/010/pdf

We added comments in the text: «(protons, neutrons and also charged pions и kaons)»

page 2, line 70:

The meaning of σ_N and σ_p should be given in the text.

Response

Thank you very much for your comment and suggestion. We've corrected it in the text:

- «According to the data for 2019, hourly averaged average count rate and atmospheric pressure for the CARPET-MOSCOW installation = 53667 pulses/h, mean square deviation of the count rate = 2187 pulses/h; = 988.7 hPa, mean square deviation of the atmospheric pressure = 9.8 hPa.»

page 3, lines 74f:

You write that you selected June 2019 for the determination of the barometric coefficient β as during this month there were no large geomagnetic and solar disturbances. From Figure 3 I would expect that the months July and August may be even more appropriate. To disentangle the barometric effect from the temperature effect, I would expect that it makes sense to also use the temperature in the atmosphere as a criterion for the selection of the time interval for the determination of the barometric coefficient.

Response

Thank you very much for your comment and suggestion. We've corrected it in the text:

«For calculating the barometric coefficient , it is necessary to determine the linear relationship between and (Fig. 2). Barometric coefficient *b* for the CARPET-MOSCOW (which is installed at the Dolgoprudny Scientific Station of the Lebedev Physical Institute RAS, Moscow region) installation is determined on the data of June 2019 (During this period there were no significant geomagnetic, solar and temperature disturbances): b = –0.1861 ± 0.0025%/hPa; coefficient of determination R^2 = 0.8975. Using Eq. (1), we obtain pressure-corrected data:»

page 3, line 80:

I would change: "Average count rate" to "Average pressure corrected count rate".

Response

Thank you very much for your comment and suggestion. We've corrected it in the text.

page 3, line 88:

Definition of $\beta \sigma_p$?

Response

Thank you very much for your comment and suggestion. It's multiplication. We've correct it in the test: «= 0.018 (1.8%),».

page 3, "2.2 Temperature effect":

I would appreciate if you could give a short description of the physics behind the temperature effect.

Response

Thank you very much for your comment and suggestion. We've corrected this phrase: «The temperature effect has two components: negative and positive. The negative temperature effect is associated with a decrease in muon fluxes during heating and expansion of the atmosphere. The positive temperature effect is associated with the appearance of additional muons, due to a decrease in the density of the atmosphere and, in connection with this, a decrease in the probability of interaction of charged pions and kaons with air nuclei. As a consequence, the probability of decays of charged pions and kaons and the appearance of additional muons increases. These two effects (positive and negative) are competitive»

page 3, lines 92ff:

I would write here something like:

"The muon component of secondary CRs is characterized by a significant temperature effect (Yanke, et al., 2011). To correct the CR measurements for this effect, it is necessary to carry out temperature measurements in the atmosphere close to the location of the CR instrument."

Response

Thank you very much for your comment and suggestion. We've corrected this phrase as

you offered.

page 5, line 146:

Can you comment on the quality of the fit with $R^2 = 0,0049$.

Response

Thank you very much for your comment and suggestion.

The positive temperature effect has the greatest impact on high energy particle detectors. In this case, we have shown that there is practically no positive effect for this low-energy detector.

page 5, line 147:

"As seen in Fig. 7, there is a slight positive temperature effect.": Can you give here some quantitative information. From comparing Fig. 4 c) with Fig. 4 d) it is hard to see any differences between the two curves.

Response

Thank you very much for your comment and suggestion.

page 12, Fig. 4:

Does Fig. 4 show data for the years 2019/2020? What is shown by the grey curve and what by the black curve?

Response

Thank you very much for your comment and suggestion. We've added to the text:

«Fig. 4. Count rate variations of the CARPET-MOSCOW installation for the period of 2020-2021: *a* – uncorrected data, *b* – pressure corrected data, *c* - pressure and temperature (negative effect) corrected data, *d* – pressure and temperature (negative and positive effect) corrected data, *e* – pressure and temperature (integral method) corrected data. Grey lines - initial data, Black lines – data with averaging by 24 points.»

page 11, Fig. 3:

Does Fig. 3 show "measured count rates" or "pressure corrected measured count rates"?

Response

Thank you very much for your comment and suggestion. We've added to the text:

«**Fig. 3.** Pressure corrected count rate variations of the Moscow neutron monitor for the period of 2019. Horizontal line – average count rate.»

page 7, "4. Acknowledgments":

In addition to NMDB you should thank the IZMIRAN group (operator of neutron monitor station Moscow). Should you also acknowledge the Federal State Budgetary Institution «Central Aerological Observatory» (CAO)?

Response

Thank you very much for your comment and suggestion. We've added to the text:

«The authors express their gratitude to the Neutron Monitor Database (NMDB) team (www01.nmdb.eu) and IZMIRAN team (https://www.izmiran.ru/) for the data from the ground network of neutron monitors and Federal State Budgetary Institution «Central Aerological Observatory» (CAO) team (http://www.cao-rhms.ru/) for providing the data of upper-air sounding of the atmosphere for 2019-2020.»

page 7, "3. Conclusion":

"The results obtained by the effective generation method and the integral method correlate with each other.": What do you mean with "correlate with each other"? From Fig. 4 graphs c) and e), it seems that they show quite large differences. Can you give here some quantitative information? E.g. ratio curve c) vs. curve e). It seems that the curve in Fig. 4 e) shows more pronounced variations than the curve in Fig. 4 c). See e.g. the decrease after day 10. Which of the curves c) or e) of Fig. 4 correspond better to the CR intensity near Earth? E.g. comparison with neutron monitor data which show almost no temperature effect.

page 5, line 147:

"As seen in Fig. 7, there is a slight positive temperature effect.": Can you give here some quantitative information. From comparing Fig. 4 c) with Fig. 4 d) it is hard to see any differences between the two curves.

Response

Thank you very much for your comment and suggestion. We've added to the text:

«There is also a correlation between the data of the Moscow neutron monitor (data corrected for the barometric effect) and CARPET-MOSCOW. According to the data for 2019-2020, for the initial CARPET-MOSCOW data: R = 0.34, for the CARPET-MOSCOW data corrected for the barometric effect: R = 0.36, for the CARPET-MOSCOW data corrected for the barometric effect and negative temperature effect: R = 0.38, for the CARPET-MOSCOW data corrected for the negative and the positive temperature effect and barometric effect: R = 0.39, for the CARPET-MOSCOW data corrected for the temperature effect according to the integral method and the barometric effect: R = 0.2.

- **Conclusion**

This paper describes the CARPET installation, designed for detecting the charged component of secondary CRs. The barometric coefficient was determined using the built-in pressure sensor. The temperature coefficient was determined by two methods using the data of the upper-air sounding. The integral method for determining the temperature effect is the most accurate, however, due to the lack of regular measurements at high altitudes (since not all sounds reach high altitudes), it can be seen that the data processed by this method are less accurate. It also shows less correlation with the data of the Moscow neutron monitor. In this connection, it is more optimal to use the method of the effective generation level, since it does not require a complete temperature profile. Also, for the CARPET-MOSCOW installation, it is possible to use only the negative component of the temperature effect, since variations of the count rate have good (R^2 = 0.8191) correlation with .»

page 6, line 156:

What is exactly the "temperature coefficient density"? Units of α?

Response

Thank you very much for your comment and suggestion. Corrected. «density of the temperature coefficient»

page 6, line 171:

This formula has again the number (7) as above before line 165.

Response

Thank you very much for your comment and suggestion. Corrected.

page 6, formula (7):

According to formula (6), I would expect also a Δx in formula (7).

Response

Thank you very much for your comment and suggestion.

–density of the temperature coefficient [%·°C^{-1}·hPa^{-1}], – temperature coefficient for a given isobaric surface [%/°C].