Cosmic Ray Intensity Variations Observed by Environmental Radiation Monitors

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Abstract

We report on the comparison of time variations observed in the gamma ray component of cosmic radiation as measured by our detectors for Environmental Radiation operated in different locations at different time of the solar activity cycle. We study the response of these detectors in the occasion of Forbush decreases and ground level events, and compare our observation with those reported by the neutron monitor network.

1. Introduction

Since September 1998 we put into operation a standard detector for Environmental Radiation (ER)[2] at the Italian Base *Dirigibile Italia* in the Arctic (Ny Alesund, Norway, 79° N, 11° E, (NyA)). A station in the polar environment is a special observatory for both components of the ER: γ-rays from airborne radionuclide and from secondary cosmic ray cascades in the atmosphere. Being the site far from continental masses the observed variations in the counting rate due to the decays of the Radon and Thoron daughters can be used to understand the transport of large atmospheric masses at mesoscale and/or local phenomena. On the other hand the small rigidity cut-off facilitate the observation of variations in the cosmic ray intensity as a consequence of solar activity manifestations. The italian base is not open all the time but can be accessed several times in a year. Mainly because of power interruptions the data recording has not been continuous. Owing to limited space of the data storage device of the PC performing the data acquisition (DAQ) and in order to limit the number of interventions, a 15min sampling time has been chosen. The average counting rate of the cosmic ray component in the range 3-18 MeV is $\sim$ 6500 counts/15min. A preliminary report of observations was presented in [1].

Here we will present the observed transient (e.g. the Forbush decreases, the diurnal variation and ground level events (GLE)) and long term (solar modulation) variations and compare them to corresponding observations by neutron monitors.

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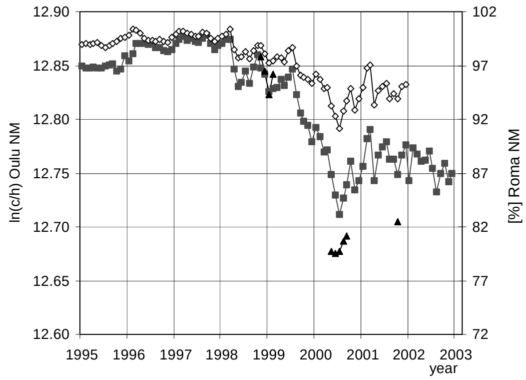

Fig. 1. Monthly data of Oulu NM (squares), Rome NM (diamonds) and NyA ER monitor (triangles). The latter are plotted on the same scale of Oulu NM

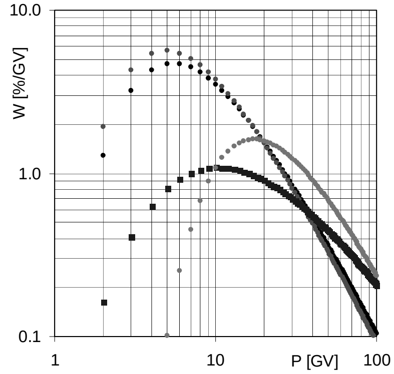

Fig. 2. Response function of our detector (squares-lower curve) compared to MT function (diamonds-middle curve) calculated by[6] and NM functions (circles-upper curves) measured by [5,8,11]

2. Meteorological effects

We have calculated the pressure correction coefficient using the data of the AWI station at Svalbard (available at the http://www.awi-bremerhaven.de). The resulting value is b_p= -(0.38 ± 0.02)%/mbar which agrees with what has been already reported [1,7] for the same type of detector at sea level and theoretically evaluated in [4].

3. Long term variations

Figure 1 shows the monthly averages of pressure corrected hourly data for the months that resulted complete compared with the monthly averages of Oulu and Rome Neutron Monitors. Unfortunately our data are rather sparse (we have several other months but incomplete). It can be seen, however, that the changes in the counting rates recorded at Ny Alesund from the end of 1998 to the middle of 2001 appear to be of about 17% and of the same size or a little larger than the similar variation recorded by a high latitude NM station. The response function for our detector has been obtained by the data collected during the two latitude surveys of 1995-96 and 1996-97 [7]. We computed it following the method of [3] and the result is compared (Fig. 2) to the one obtained with the same surveys for NM [5,8,11] and the one for a muon telescope (MT) [6]. As it can be seen the response of our detector is covering a wide range being higher than the MT response at low rigidities and a little higher than NM response at high rigidities.

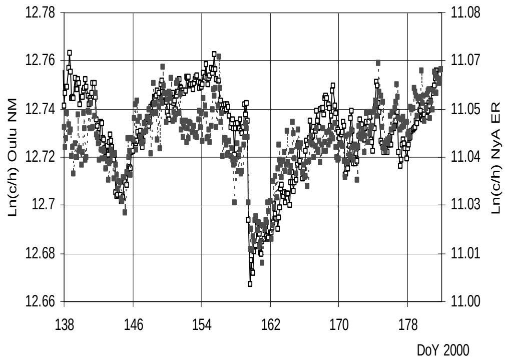

Fig. 3. FD observed by the Oulu NM (black dots) and the NyA ER monitor (open squares)

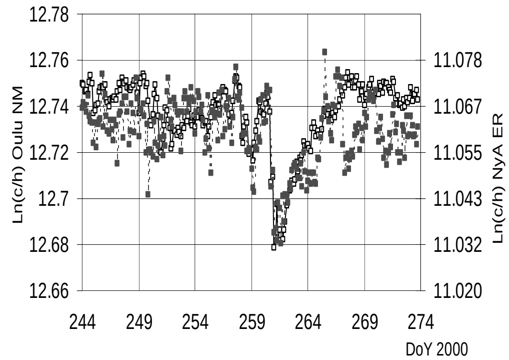

Fig. 4. FD observed by the Oulu NM (black dots) and the NyA ER monitor (open squares)

4. Transient variations

As an example of transient variations observed by our ER monitor compared to NM observations we show here two Forbush Decreases (FDs) [June 9 and Sept. 17-18, 2000] (see Fig. 3 and 4) and the *Bastille event*, the GLE of July 14th, 2000 (see Fig. 5). The ratio between the amplitude of the variations observed by the ER monitor and the Oulu NM in the case of these and other similar FDs is about 0.6. Let us note that while we observe a fair agreement between the shape of the FD as observed by the two different types of detectors located at similar high latitudes, sometimes the ER monitor show different behaviors during the recovery phase of the decrease. These effects are now investigated in more details in order to check their origin. In the case of the ground level enhancement of July 14, 2000 our minimum sampling time was 15 min, so we cannot draw very firm conclusions. We observed an increase of the counting rate of about 5%. Even if the statistics of the event is low in our monitor we think it is interesting the observation of some features during the decay phase of the event that seem common to both records.

5. Conclusions

We think that the few examples here reported can give an account for the potential of our detector for monitoring and studying cosmic ray time variations. The characteristics of our standard detector appear to be similar and complementary to those of NM and MT at ground level. Moreover it offers the great advantage of small dimensions, being easy to transport to unconfortable sites and to be put into operation. Since this summer our detector at Ny Alesund will be remotely controlled so to be operated without long interruptions.

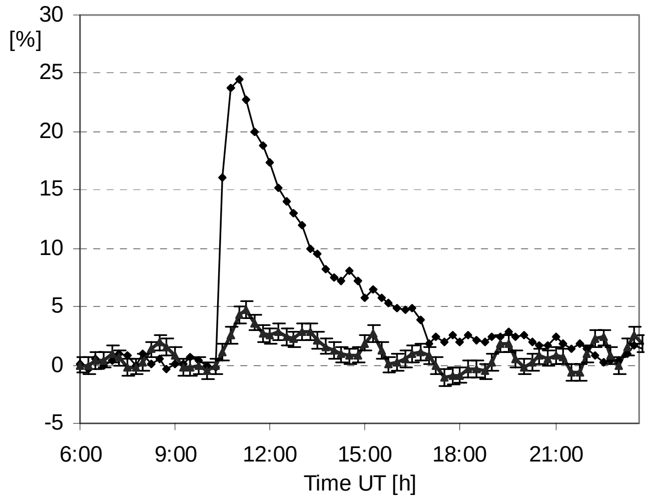

Fig. 5. The *Bastille event*: NyA ER monitor (curve with errors), Oulu NM (black dots)

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7. References

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