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Long term observations of the Environmental Radiation in Antarctica

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Abstract

For more than one year a NaI scintillation detectors of the Environmental Radiation has been continuously operating at the Italian Antarctic base. We have reconstructed the series of hourly observations of the airborne radioactivity plus cosmic rays in the range 0.1- 3 MeV and the hourly counting rate of soft cosmic rays components in the range 3-18 MeV. The two series show different dependence on weather conditions. Only very preliminary discussion of the observations is presented as the necessary meteorological information is not yet available.

1 Introduction:

After two latitudes surveys of the Environmental Radiation [ER] (cosmic rays and γ from airborne radionuclides with E>50keV) [Cecchini et al, 1997; Galli et al., 1997], one of our standard detector has been operating at the Italian Antarctic base at Terra Nova Bay (74.7S, 164.12E) since Dec. 7th, 1997. It registered data almost continuously, with only few interruptions, till the end of year 1998. At present it is still collecting data after the seasonal closure of the base, of the end of February 1999. The aim of the project is to establish a permanent station for ER monitoring in Antarctica for the study of the solar activity variations, by means of cosmic ray observations, and of the atmospheric transport mechanisms of aerosol and possible local phenomena, by means of the airborne γ radionuclide surveillance. At present the data must be removed from the storage memory of the PC controlling the data acquisition by actually operating on the PC. Future plans foresees some remote control and transmission of data via telephone connection. Here we report the first analysis of the data collected during the solar year 1998. At the moment of submission of the paper the data on atmospheric pressure and other meteorological variables (e.g. temperature, wind speed and direction etc.) were not yet available, so the discussion of the phenomena that have been observed is at present by far incomplete.

2 The Acquisition History:

The detector of the type already presented in Galli et al [1997a] was put in operation in a room of the main building of the Italian Base (BTN) Dec. 7th of 1997. Due to its movement to another room better designed to allow the running of the experiments during the austral winter and before the closing of the base (Feb. 27th, 1998), the acquisition was interrupted and then again resumed a few times. Apart from these interruptions and a few more when the base was reopened at the end of October-beginning of November 1998, due to some problems on the power generators, the acquisition was continuous throughout the year. We have divided the pulse spectrum registered every hour by our detector, into three energy bands [100keV-3.0MeV], [3.0-8.0MeV] and [8.0-18MeV] that we identified as radioactivity (Rad), ultrasoft (US) and soft (S) cosmic rays [CR] respectively. The plot of the hourly counting rate series is reported in Fig. 1.

3 Qualitative analysis of ER monitoring:

An inspection of the data in Fig. 1 reveals that:

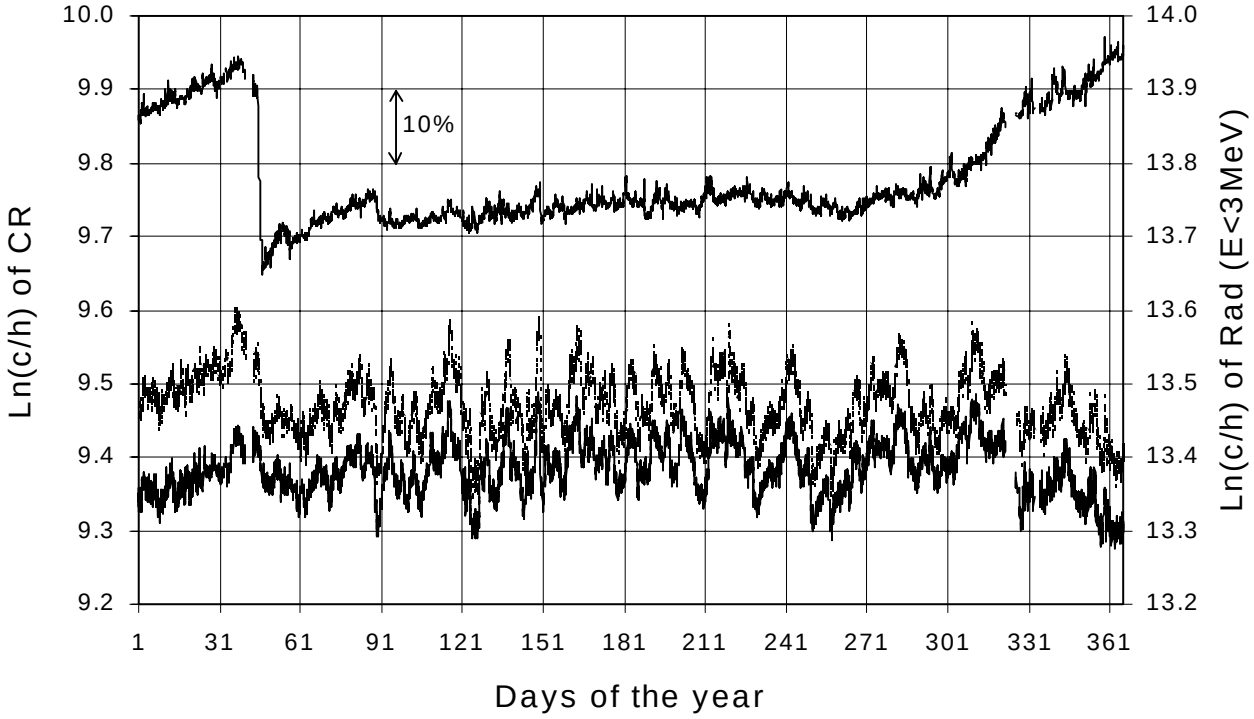

Figure 1: Time series of Rad (top), US CR (middle) and S CR (bottom) hourly counting rates recorded at BTN during the solar year 1998.The data are plotted as natural logarithm of the rates in order to compare more easily the fractional variations of the rates. The average values are about 970000 c/h, 13000 c/h and 12000 c/h for Rad, US CR and S CR respectively.

1. there has been a marked decrease of 25% on the counting rate of low energy band (Rad) from CR γ's and airborne radionuclides (see Fig. 2 for details); the intensity recovered a little in the following 40 days and then it almost levelled off until started to rise again by the middle of September, eventually reaching the level of the end of January. From a periodic report on research activities at Baia Terra Nova base (BTN) it comes out that there has been a heavy snowfall that lasted 3 days ending the February 16th, 1999; this event was classified as "unusual for intensity and duration". Moreover there were 2 "almost historical minima" of atmospheric pressure, of 945 and 950 Hpa, the latter coinciding with the start of the snowfall.
2. The aforementioned decrease is seen also in the CR records but with different amplitudes; after that the data records of both US and S CR bands show strong parallel oscillations that continue till the end of the year; there is no apparent recovery of these counting rates at the end of the year on the contrary to what is observed in the Rad band (see Fig. 3); again in the report of the Italian base it is noted that surface temperatures at the end of October 1998 were well above the seasonal average values.
3. The two counting rates referring to the CR show peculiar variations (see Fig. 4) apparently not related to pressure variations.
4. The large variations observed in the CR counting rates are due to pressure variations, as already noted in Galli et al. (1997b); small peculiar variations of the radioactivity band are connected to pressure changes and to windy conditions; this explanation follows from previous observations (Galli et al, 1997); unfortunately at present we cannot substantiate this hypothesis also for the new data series because of the present lack of meteorological data.

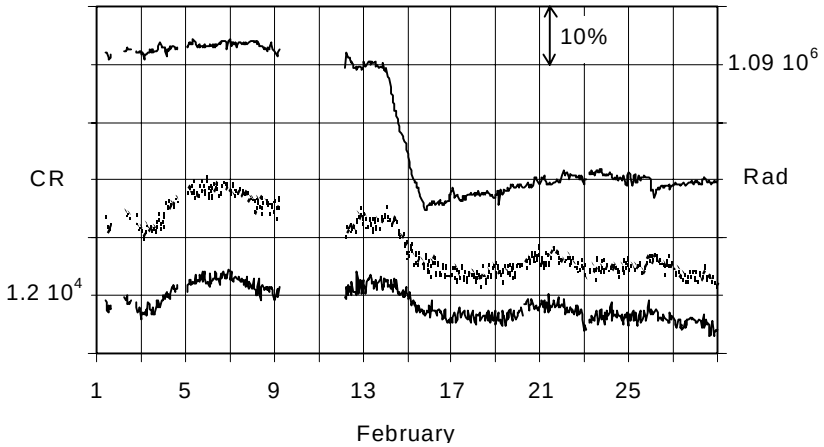

Figure 2: Expanded view of the fractional variations of the hourly counting rate: Rad with E<3 MeV (top), US CR (middle) and S CR (bottom) at BTN during the period of the heavy snowfall at the middle of February 1998.

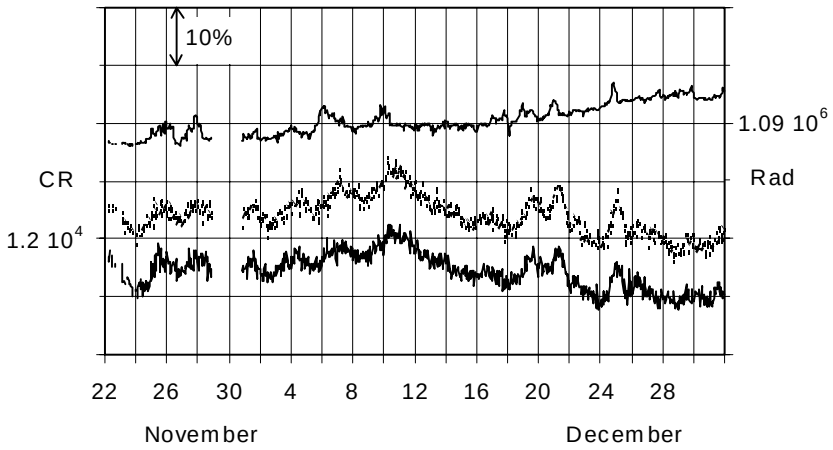

Figure 3: Expanded view of the fractional variations of the hourly counting rate: Rad with E<3 MeV (top), US CR (middle) and S CR (bottom) at BTN during the period of November - December 1998.

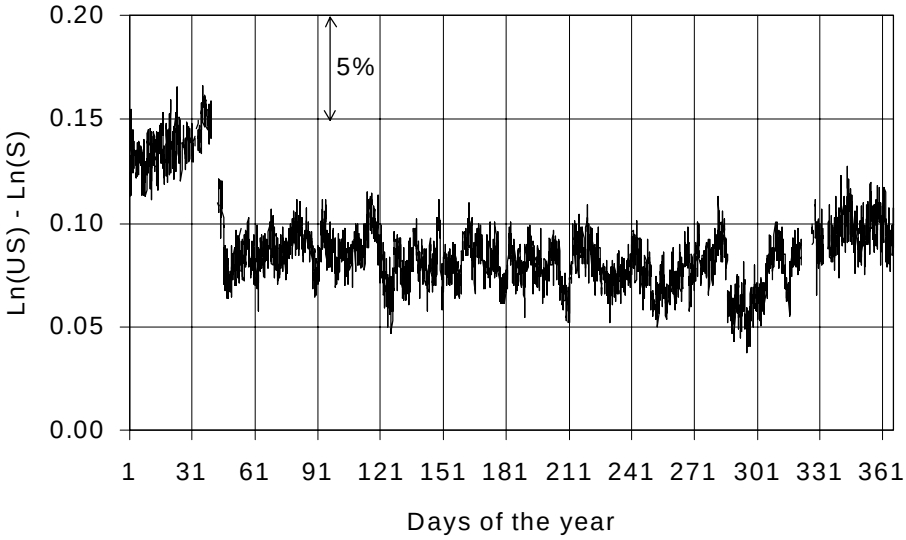

Figure 4: Difference of fractional variations of US CR and S CR bands registered at BTN base during the year 1998.

5. By comparing the three series one can notice that there is a strong correlation on short time scale (2-5 days) between the fluctuations of Rad and those of either US or S CR; this seems to indicate that a considerable (consistently larger of what is observed at lower latitudes) part of the time variations of radioactivity counting rate is due to variations in CR whose spectrum extends well below the 3 MeV. The regression analysis for the period May 1th –25th gives a reasonable value, r = 0.63.

4 Conclusions:

The detector we have realised for the continuous monitoring of the ER has proved its reliability being able to work continuously for almost one year, but with few interruptions mainly due to human interference. The observed low energy band variation appears very extraordinary, involving the radionuclide aerosol initially swept out by the snow but afterward recovered by the effect of the atmospheric circulation over the Antarctica continent. The analysis of the data collected is at present very preliminary and qualitative due to the lack of the meteorological data as their retrieving is going on. We hope to present an updated and more complete analysis at this Conference.

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