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Multiple Time Scales Study Of the Modulation Of The Cosmic Ray Flux

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Abstract. We present experimental results on the long-term modulation of cosmic rays (CR) related to the solar cycle and on shorter timescale related to the natural radiation from precipitated rain. A preliminary correlation between CR and the amount of precipitated rain water indicates the possible influence of the atmospheric electric field

Keywords: Cosmic Rays, Solar Activity, Rain, Atmospheric Electric Field
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A new Cosmic Ray detector (CARPET) has been successfully installed and tested at the El Leoncito Astronomical Complex (CASLEO), San Juan, Argentina (2550 m, Rc ~ 12 GV) in April of 2006. The scientific goal of this new instrument is the study of the cosmic ray (CR) flux modulation in different time scales: long time scales related to the 11 (and 22) years solar activity cycle, and shorter variations due to transient solar and atmospheric phenomena. The CAPERT detector provides three channel records: UP and LOW sensitive to low-energy CR and γ-ray radiation and TEL only sensitive to high-energy CR. In this paper we present recent observational results on the modulation of CR flux detected by the CARPET device.

Since the CARPET was installed the solar activity has been almost constant at very low levels. However, the CARPET did observed variations due to transient solar phenomena. On 2006 December 6, the CR flux records presented an increase correlated with an intense solar flare accompanied by a large flux of protons above 100 MeV. The CARPET has also detected Forbush decrease events in association with solar CMEs whose launches were identified on the solar disk a few days before.

In Figure 1a we show the modulation of the records from the TEL channel of the CARPET device since its installation in April of 2006. We note a seasonal modulation due to the atmospheric temperature variation. More importantly, the CARPET does observe a small increasing (lower dotted curve) trend which is associated with a slightly decreasing solar activity (upper dotted curve).

The CARPET has detected about 100 events associated with precipitation of rain water in the form of (5-25 %) increases of the count rates detected by the LOW and UP channels. These events are due to low energy γ-rays associated emitted by radioactive nuclei [1,2]. In a preliminary analysis we correlated the impulsivity of the CARPET events against the total amount of precipitated rain water (in mm) and we found the two different linear correlations. This result

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suggests that another physical mechanism is at work to account for the observed time variations of the CR flux.

It is known that rapid fluctuations of the CR flux can also be due to variations of the quiescent atmospheric electric field due to electrically charged clouds, thunderstorms and/or lightning [3]. We installed in January of 2008 a new device close to the CARPET in order to measure the local atmospheric electric field and its time variations. Since then, all increases of the CR flux observed by the CARPET were found in association with temporal changes of the atmospheric electric field, with or without precipitation of rain water (see Fig. 1b).

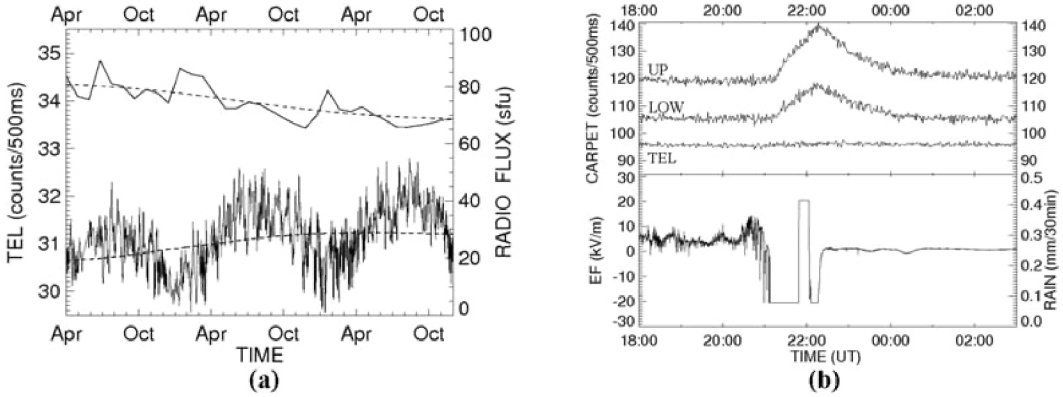

FIGURE 1. **(a)** TEL channel count rate variations (bottom curve) and the 10.7 cm solar flux (top curve) since 2006 April. **(b)** UP and LOW count rates (upper curves) associated with atmospheric electric field changes (bottom curve).

Concluding remarks. We have presented observations obtained with the CARPET device installed at CASLEO. The available database consists in ~ 2.5 years of records. On long timescale related to the solar activity cycle we have shown that the high-energy component of the CR flux presented a slight trend increase (1.6%) associated with a small decrease in solar activity. On shorter timescale the CR flux varies with the natural radioactive radiation from the precipitated rain water and the electrical activity of the atmosphere. These observations show the good sensitivity of the CARPET device.

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