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The GLE of July 14, 2000 registered by the Antarctic Laboratory for Cosmic Rays with 1-min time scale

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Abstract. The **A**ntarctic **L**aboratory for **C**osmic **R**ays (LARC) of the Chile/Italy long-term collaboration registered the Ground-Level Enhancement (GLE) of July 14, 2000. A report with the LARC data, based on the 5-min time scale, was published using the standard international format for GLEs (Cordaro et al., 2000a). Here we present the 1-min LARC records for the event. Moreover, we compare the LARC hourly data with the ones obtained at Los Cerrillos (LSRC, Santiago) with a multidirectional muon telescope. No clear GLE signatures are found at high energies (> 10 GeV). Also results from the preliminary analysis of the April 15 and 18, 2001 GLEs are shown.

1 Introduction

Since January 1991 the Antarctic Laboratory for Cosmic Rays (LARC) operates with a standard neutron monitor (6-NM-64 type; Storini and Cordaro, 1997; Storini et al., 2000a) on King George Island (South Shetlands: geographic coordinates: 62. 20º S and 301.04° E; height: 40 m a.s.l.). Also a Multidirectional Muon Telescope is detecting cosmic ray radiation in Chile from 1980 to the present (Los Cerrillos station; acronym: LSRC; 33.45° S and 289.40° E; height: 570 m a.s.l., Santiago). The main scientific goal for both research projects is the survey of the cosmic ray variability in the high (LARC) and middle (LSRC) latitudes of the Southern Latin–American sector. For this reason, the identification of Ground Level Enhancements (GLEs), induced by energetic solar cosmic rays, is seen as a priority task (Storini, 2001). We recall that LARC and LSRC stations are reached by charged particles having rigidities exceeding about 3 and 10 GV, respectively (e.g. Storini et al., 1995; 1999; 2000b). Hence, in this context, the Chile/Italy collaboration for LARC deserves special attention, being the geomagnetic shielding effect minor in the Antarctic ground.

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The main time resolution for LARC measurements is five minutes (due to the statistical error), but since February 1999 also the 1-min data acquisition is performed.

2 LARC response to Ground Level Enhancements

During the present LARC operative time (1991-2001) eleven GLEs have been registered by the world wide network of cosmic ray detectors. They are, according with the international numeration, the events n. 51 (June 11, 1991) to n. 61 (April 18, 2001). For all of them the required data files, on 5-min time scale, were prepared (Storini et al., 1993; Cordaro et al., 1995, 2000b; Massetti et al., 1999a,b,c, 2000a,b, 2001; Olivares et al., 2001) and sent to the World Data Centers for GLEs: Air Force Research Laboratory at Hanscom AFB/MA, USA and the Australian Antarctic Division, Kingston/Tasmania, Australia).

3 The July 14, 2000 GLE event

A summary of the characteristic parameters associated with the July 14, 2000 GLE can be made from data obtained from the Web site http://www.ngdc.noaa.gov. Activity on the sun begins around 10.03 on NOAA Active Region 9077. The solar flare was located at about 22°N and 07°W (class X 5.7/3B) and starts at 10.12 U.T., with maximum values between 10.20 UT to 10.25 UT. The solar radio emission shows outstanding occurrences at selected fixed frequencies, with a clear evolution from 10.10 UT to 10.25 UT. All these events show a definitive maximum at 10.24 UT; it was seeing, besides a radio type IV burst, the halo CME, the type II burst and relativistic protons (e.g. Kosovichev and Zharkova, 2001; Yan et al., 2001; Zhang et al., 2001; among others).

The LARC rate of the intensity variability (in %) during July 14, 2000 for 1 minute, 5 minute an hourly data is shown in Figure 1, together with the July hourly intensity.

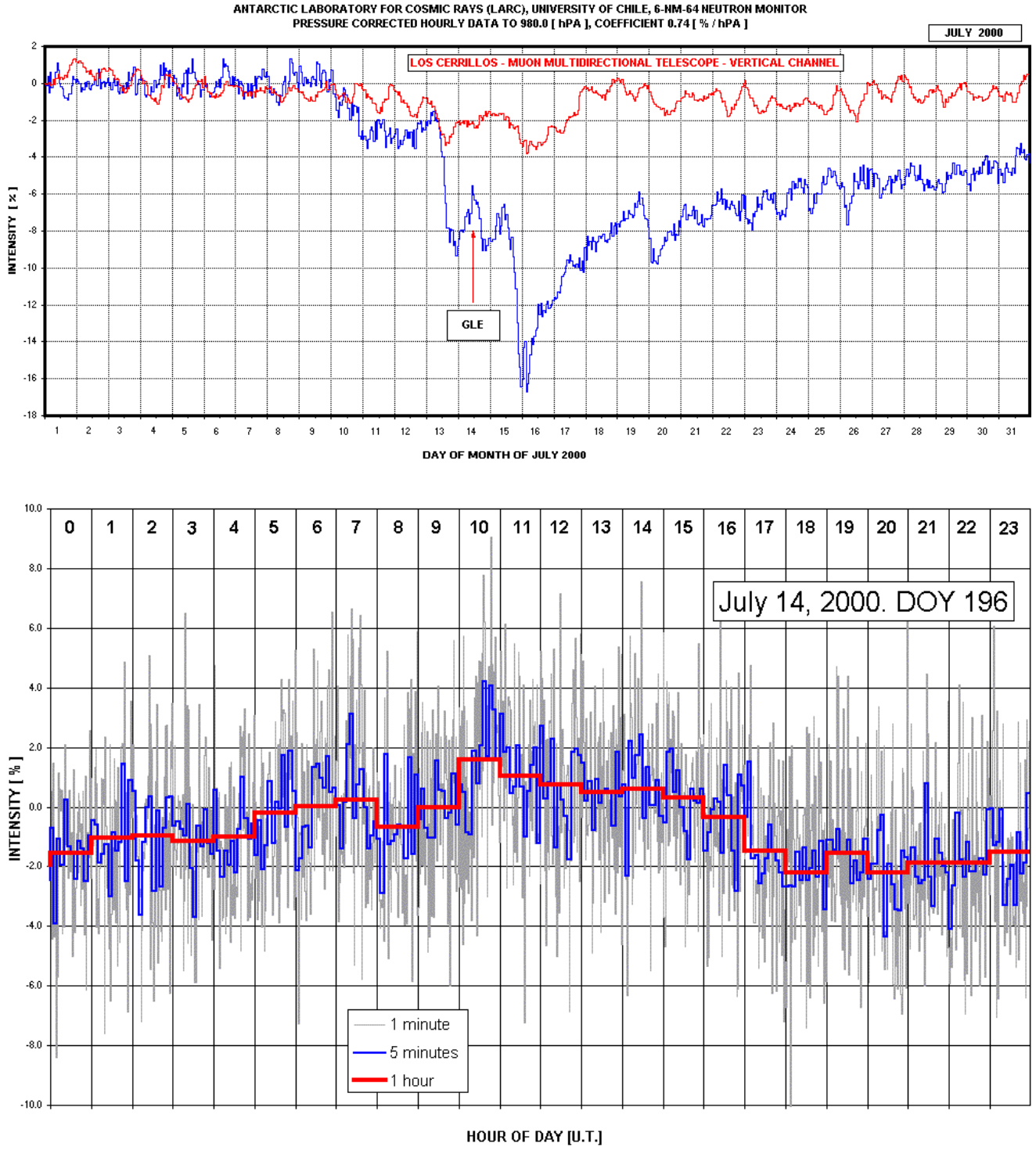

Fig. 1 – LARC rate corrected for pressure variations during July 14, 2000 (lower panel; the reference level (0%) corresponds to 09:00 UT). The July 2000 hourly counting rates for LARC (6-NM-64; King George Island - Antarctica) and LSRC (multidirectional muon telescope; Los Cerrillos – Santiago - Chile) are also shown (upper panel).

As shown in Figure 1, the Forbush decrease events registered by LSRC and LARC stations during July 2000 were outstanding events, implying a high activity level on the sun. However, the solar cosmic rays emitted were not very energetic, because no clear traces of the GLE can be found in the LSRC records. We suggest that the July 14, 2000 event is dominated by charged particles with energies below 10 GeV.

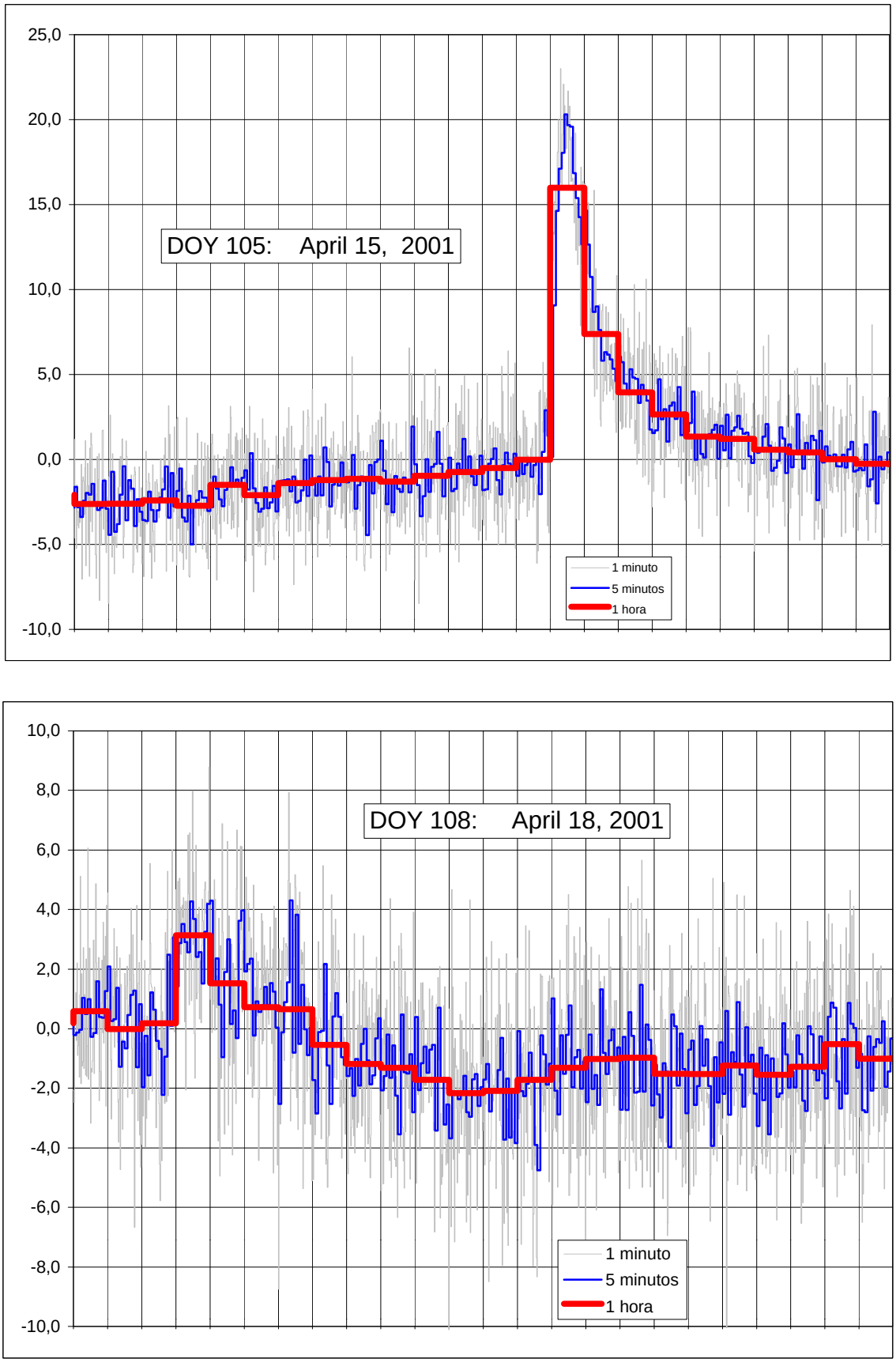

Fig. 2 – LARC (King George Island – Antarctica) response (%) to the cosmic ray incoming during the 24 hours of April 15 and 18, 2001 (unit for horizontal axis is one hour).

4 The April 2001 GLE events

During the current year other two GLE events have been detected by the world-wide network of cosmic ray detectors. In Fig. 2 we show the preliminary data registered by the Antarctic Laboratory for Cosmic Rays. The first event is very sharp, with a maximum increase of about 20% from the 13-14 UT level (upper panel of Fig. 2), while the second one is small (about 4% from the 01-02 UT level; lower panel of Fig. 2).

Conclusion

From the GLEs reported (Fig. 1 and Fig. 2) it is clear that only for huge GLE events the 1-min time scale of records is useful. Otherwise, it is necessary to expand the recording device with more counters to improve the statistics.

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