Cosmic-ray Characteristic Parameters for Yangbajing (Tibet) Experiments

Marisa Storini[1,2]
(1) Institute for Interplanetary Space Physics, National Research Council, Via del Fosso del Cavaliere, 100, 00133 Rome, Italy
(2) INFN - Roma Tre Section, Via della Vasca Navale, 84, 00146 Rome, Italy

Abstract

The geomagnetic shielding imposed on the charged particle access to the Yangbajing measurement site is discussed. The R_c time dependence on the McIlwain's parameter resulted to be the same found in the past by Shea et al. (1987). Moreover, huge geomagnetic perturbations change the rigidity threshold of the cosmic ray incoming even at this Tibetan location.

1. Introduction

Yangbajing location (shortly: YANG; geographic coordinates: 30.11° N - 90.53° E, height: 4300 m a.s.l.) was selected in the past for its *high-altitude full coverage* to reach a good sensitivity with ground-based cosmic ray (CR) instruments. Nowadays, several experiments are working to solve many items of astroparticle physics (e.g. Storini et al., 2001 and references therein).

A detailed study of the CR characteristic parameters for YANG site was undertaken inside the ARGO-YBJ international project, with the aim of describe expected features in the rigidity range below ∼ 150-200 GV. Due to space limitations, the geomagnetic shielding imposed on the charged particle access to the measurement site is only discussed.

2. Yangbajing characterization using the quiescent geomagnetic field

A high-order mathematical model (10th order) of the quiescent geomagnetic field was recently used to evaluate the CR characteristic parameters for YANG. More precisely, applying the International Geomagnetic Reference Field for Epoch 1995.0 (IGRF95, Sabaka et al., 1997) it was determined the lower (R_L), the upper (R_U) and the effective rigidity cutoff (R_c) for vertical and non-vertical (15° and 30°) incident particles at the YANG site (Storini et al., 2000). Also some particle asymptotic directions, in the rigidity range up to 100 GV, were derived considering the cardinal directions: N, NE, E, SE, S, SW,W and NW (Storini et al., 2001).

pp. 4283–4286

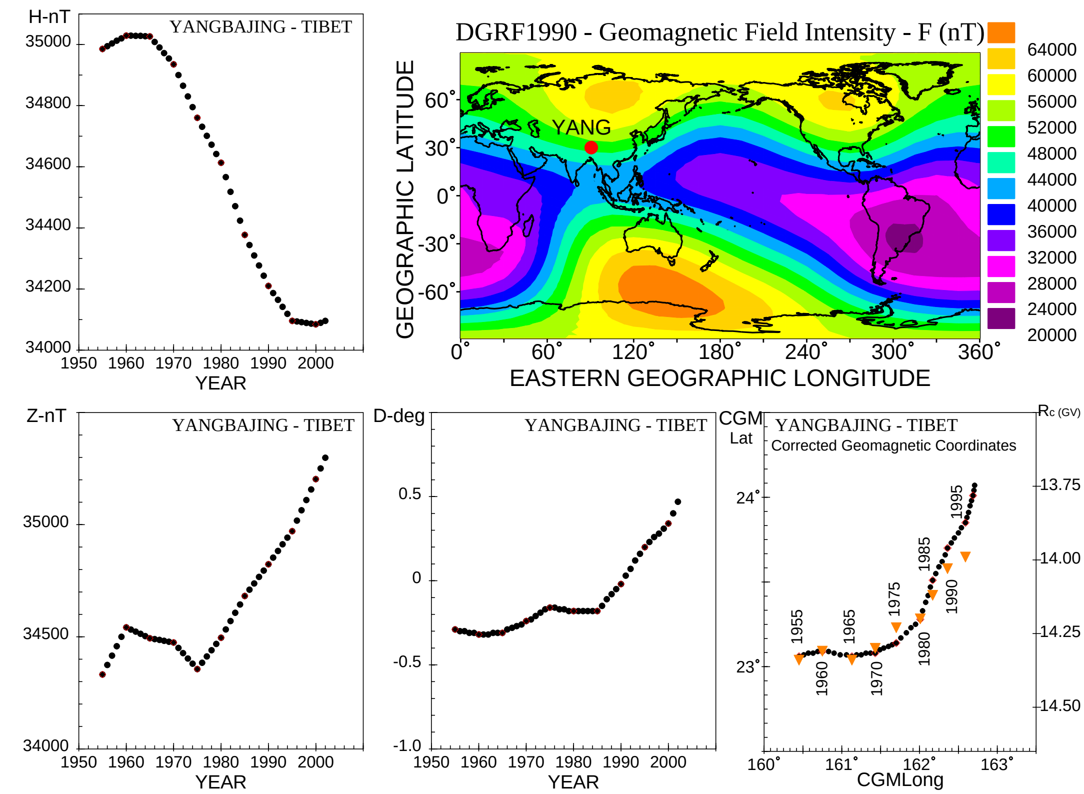

Fig. 1. Earth's magnetic field total intensity (F) evaluated from the DGRF1990 model (upper right panel; Yangbajing site is indicated by a filled circle: YANG) together with the yearly change in the magnetic field components at 20 km altitude (Horizontal: H, Vertical: Z and Declination: D) for the Yangbajing location, the corrected geomagnetic coordinates and the rigidity cutoffs (R_c: inverted triangles; Shea and Smart, 2001) for the incoming vertical direction.

Moreover, Shea and Smart (2001), by using the 5-year incremented standard models for the quiescent geomagnetic field (from Epoch 1955.0/DGRF55 to Epoch 1995.0/IGRF95), have investigated induced effects by the secular variation of the geomagnetic field on the CR access to several measurement sites. Among them, YANG is present. Their results suggest a soft R_c decrease from 1955 to 1995 ($\Delta R_c = 0.35$ GV). To follow such variability the yearly change of the geomagnetic field components from 1955 to 2002 were computed for the YANG location at an altitude of 20 km, being this altitude the one in which most of the CR particles create the nuclear cascade. Also the corresponding corrected geomagnetic (CGM) coordinates were evaluated by using the web pages of NASA's National Space Science Data Center. Fig. 1 (upper right panel) shows the derived global contour levels of the total geomagnetic field intensity for the 1990 year and the time variability of three field components at YANG: Horizontal (H),

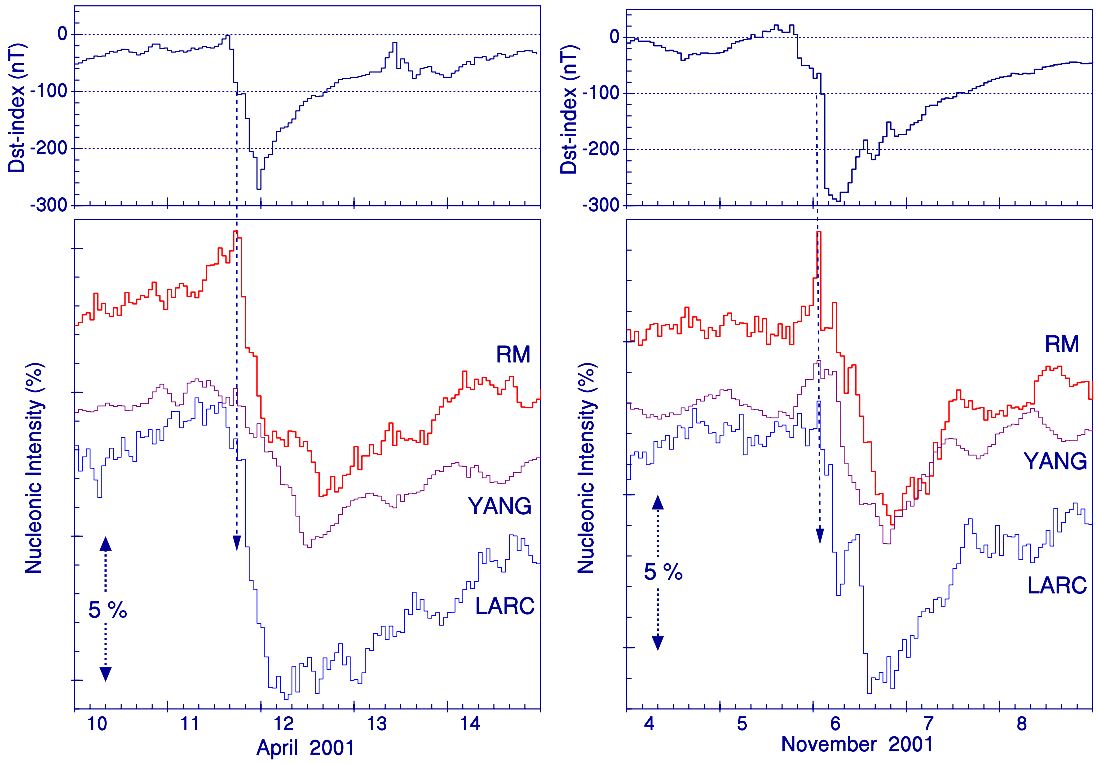

Fig. 2. Dst-index and nucleonic intensity variability for two outstanding geomagnetic pertubed time intervals (see the text for details).

Vertical (V) and Declination (D). The lower right panel reports the yearly CGM coordinates together with the R_c values (inverted triangles) derived by Shea and Smart (2001). From this panel it is easy to see that cutoffs match the CGM coordinates rather well, except for 1995 (but this R_c value is provisional because it was computed from the IGRF95 model). A very good correlation exits between R_c and cos(CGMLat) or $\cos^2$(CGMLat) and the derived L parameter (McIlwain, 1961) changes from 1.181 (1955) to 1.195 (1995). Results are consistent with past estimations of the R_c time dependence on the McIlwain's parameter, i.e. proportional to $L^{-\alpha}$, with $\alpha \sim 2$ (Shea et al., 1987): $\alpha_{YANG} = -2.0 \pm 0.1$.

3. Yangbajing characterization during geomagnetic perturbed levels

To characterize YANG site during enhanced geomagnetic perturbations the hourly pressure-corrected data of the YANG 28-NM64 (pressure average Po = 607.0 hPa), Rome 17-NM64 (RM; Po = 1009.25 hPa) and the Antarctic 6-NM64 (LARC; Po = 980.0 hPa) were considered for two time intervals: April 10-14 and November 4-8, 2001. Fig. 2 shows the Dst-index (WDC for Geomagnetism/Kyoto) and the nucleonic intensity variability for those periods. For both events the Dst level was near - 300 nT. During the time intervals indicated by a downwards arrow RM ($\sim$ 6.3 GV) shows an intensity increase which is absent for the first event and much smaller for the second one at LARC ($\sim$ 2.9 GV). From the YANG data it is clear that also at $\sim$ 14 GV enhanced geomagnetic perturbations, as described by the Dst-index, affect the Tibetan CR registrations. Kudela and Storini (2002) described a similar geomagnetic perturbation occurred in March 2001 (Dst = - 358 nT). The CR increase seems to be related with the lowering of the rigidity threshold at the measurement sites, particularly for the middle-latitude CR detectors (Flueckiger et al., 1983).

4. Conclusion

Results related with the YANG characterization for CR experiments using the quiescent geomagnetic field are reported. Moreover, from two case studies, it is concluded that external geomagnetic field models should be considered for a right evaluation of the particle incoming to the YANG detector during huge geomagnetic storms, which seems not to be necessary for low/moderate perturbations.

The YANG-NM is supported by the Institute of Physical and Chemical Research/Wako/Japan, the RM-NM by the IFSI/UNIRoma3 Collaboration, while LARC by the IFSI/UChile Collaboration, via INACH and PNRA. Thanks are due to the WDC-C for maintaining NM data records.

5. References

1. Flueckiger E.O., Smart D.F., Shea M.A. 1983, JGR 88, 6961
2. Kudela K., Storini M. 2002, ESA SP-477, 289
3. McIlwain C.E. 1961, JGR 66, 3681
4. Sabaka T.J. et al. 1997, J. Geomag. Geoelectr. 49, 157
5. Shea M.A., Smart D.F. 2001, Proc. ICRC 2001 10, 4063
6. Shea M.A., Smart D.F., Gentile L.C. 1987, Phys. of the Earth and Planet. Int. 48, 200
7. Storini M., Smart D.F., Shea M.A. 2000, SIF Conf. Proc. 68, 45
8. Storini M., Smart D.F., Shea M.A. 2001, Proc. ICRC 2001 10, 4106