SHORTER CONTRIBUTIONS

PROTON FLARES IN THE VARIATION OF THE AURORAL ELECTROJET IN SOLAR CYCLE No 21

LADISLAV KŘIVSKÝ, FRANTIŠEK ZLOCH

Astronomical Institute, Czechosl. Acad. Sci., Ondřejov*

Summary: The effects of the solar proton flare product on ionospheric circumpolar currents (Auroral Electrojet Index) for the interval 1978–1986 (solar cycle No 21) are investigated. A significant increase of the AE two days after the zero-day of appearance of the proton flare was displayed.

1. INTRODUCTION

The present paper was intended to investigate the effects of the emission of solar proton flares on the index derived from the disturbance of the magnetic field, which reflects the magnitude of electric currents in the subpolar region; this is the Auroral Electrojet (AE) index, defined by Davis and Sugiura [1] and published in [2]. The AE index represents a quantitative measure of global auroral zone magnetic activity produced by enhanced ionospheric currents, flowing along the margin of the auroral oval. After Davis and Sugiura AE has been shown to be especially useful to delineate the onset and progressive development of high latitude magnetic disturbances which are recognized as one aspect of magnetospheric substorms [3, 4].

AE is derived from horizontal magnetic field data from a group of magnetic observatories located in the Earth's auroral zone. Detailed method of construction of AE index is also described in our paper [7] in which we have studied changes of this index in days about the appearing of the proton flares in the cycle No 20.

For our treatment we have used the daily values of the AE indices published in [2] for years 1978–1986. The data of the year 1977 are not received. The AE is expressed in units of gamma (1γ = 10^-5 G = 1 nT).

Using the zero method (superposed epochs [5]) the manifestation of the mightiest events of solar activity on the pattern of the AE index was investigated, i.e. of proton flares associated with ejections of cosmic and subcosmic radiation. The proton flares are not only connected with fast particles but also with slow magnetoplasmic products.

The presented paper represents second treatment of such kind for another interval of data of further solar cycle.

2. PROTON FLARES AND AE INDEX

The proton flares used for determining the zero days for the method of superimposed epochs were taken from the catalogue in [6]. Their number in the interval of years 1978–1986 was n = 50. The AE index values were investigated 10 days before the zero day and 12 days after it. An average pattern was obtained. Besides this, the histogram of the number of occurrence of the maxima of the AE index values in the individual days, derived from the individual epochs, was superimposed on the same graph. If the patterns of both are roughly the same, we have a realistic issue resulting from the occurrence of such patterns predominantly; the first curve will not be

*) Address: Astronomical Institute, Ondřejov 251 65, Czechoslovakia

Studia geoph. et geod. 36 (1992) 293
due to singular incidentally large values, which would affect the average resultant values in the individual days around the zero day.

The resultant pattern implies that the AE curve is in the days $-10$ to $+1$ low, in the $+2$ day reach its peak and after then a decrease followed. The increase was from the pre-flare level of $\sim 240 \gamma$ to about $410 \gamma$ AE. The resultant amplitude relative to the normal level of statistical noise amount $150 \gamma$ AE. The typical occurrence of single maxima of AE on days of single epochs was $n = 2$ (see histogram on the Fig. 1), the maximum of the occurrence of peaks is $n = 14$ and was centered on $+2$ day. This extreme is followed by a decrease. As we received by treating the same relations for preceding solar cycle No 20, the proton flares are not the only cause which is capable of affecting the AE index substantially, also another important flares can produce such analogical effects [7].

3. DISCUSSION AND COMPARISON OF RESULTS IN TWO SOLAR CYCLES

It was found in both cycles No 20 [7] and No 21 that proton flares affect the AE index statistically in a significant way from the point of view of the maximum amplitude, as well as the dense concentration of the occurrence of maxima values of single epochs into 2nd to 3rd days after the appearance of the proton flare (Fig. 1). Particularly enhanced level of both studied values few days before the zero day in the cycle No 20 we have not found in cycle No 21. The appearance of the AE-peak on 2nd day after the proton flare indicates that the effects of generation of iono-

![Image](image-url)