THE RELATION BETWEEN THE AE-INDEX AND RADIO EMISSIONS OF THE SOLAR CORONA

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ABSTRACT. Connections between the enhanced average daily values of the AE-index and flare activity in selected intervals of the 20th solar activity cycle are sought. The cases in which a coronal emission was recorded at frequencies of 29 and 33 MHz under enhanced flare activity are investigated. The effect of the sector boundary crossing of the interplanetary magnetic field and of the occurrence of various types of the dynamic radio spectrum on the variations of the daily values of the AE-index is also studied.

СВЯЗ МЕЖДУ АЕ ИНДЕКСОМ И РАДИОВСПЛЕСКАМИ СОЛНЕЧНОЙ КОРОНЫ. В работе исканы связи между повышением средних суточных величин АЕ индекса и вспышечной активностью в вибраных периодах 20-ого цикла солнечной активности. Исследуются случаи, в которых во время повышения вспышечной активности были регистрированы емиссии в короне на частотах 29 и 33 МГц. Тоже исследуются влияния перехода пределов мезпланетного магнитного поля и появление различных типов динамического радиоспектра на изменения суточных величин АЕ индекса.

SOUVISLOST AE-INDEXU S RADIOVÝMI EMISEMI SLUNEČNÍ KORONY. V práci jsou hledány souvislosti zvýšení průměrných denních hodnot AE indexu s erupční aktivitou ve vybraných obdobích 20. cyklu sluneční aktivity. Jsou zkoumány případy, kdy při zvýšení erupční aktivity došlo k emisi v koroně zaznamenané na frekvenci 29 a 33 MHz. Rovněž je sledován vliv přechodu hranic meziplanetárního magnetického pole a výskytu různých typů dynamického radiového spektra na změny denních hodnot AE indexu.

The relation of the AE-index (Auroral Electrojet) to manifestations of solar activity have been studied in a number of papers (e.g. Křivský, 1978). The AE-index indicates the degree of development of the circumpolar electric currents in the ionosphere. In this paper, we shall study the relations between the average daily values of the AE-index and the radio emissions of

the solar corona at frequencies of 29 and 33 MHz, recorded at the observatory Úpice. These frequencies originated at coronal heights of about 900 000 km.

A total of 23 active regions, which passed across the solar disk independently, during the 20th solar activity cycle, were selected. Aggregate curves of flare activity were constructed using the F-index ($F = I \times t$, where I is the overabundant importance and t the duration of the flare), and the polarity of the interplanetary magnetic field (Svalgard, 1976) and the radio emissions in the corona on frequencies of 29 and 33 MHz were marked on them for the individual days using the unpublished catalogue of Křivský and Klimeš, in which the bursts have been divided by duration into 4 classes:

Class A - duration 2 mins; Class B - duration from 2 to 5 mins;

Class C - duration from 5 to 10 mins; Class D - duration over 10 mins.

Radio emissions related to flares were marked separately.

The average daily values of the AE-index (UAG Rep.) were plotted for the individual days. We then investigated whether the radio emissions in the corona were related in some way to the enhancements of the average daily values of the AE-index. The cases in question divided into three groups: Group 1, in which the average daily values of the AE-index are observed to increase after a radio emission in the corona (Fig. 1), contains 12 cases; Group 3, in which it cannot be determined whether the increase in the average daily values of the AE-index is related to a radio emission in the corona, or to the sector boundary crossing of the interplanetary magnetic field (Fig. 3), contains 8 cases. The graphs pertaining to Group 1 indicate that the increase in the average daily values of the AE index, following a radio emission, occurs on the 1st to 6th day, on an average.

The relation between the average daily values of the AE-index and the radio emissions in the corona on 33 and 29 MHz was also studied using the superimposed-epoch method. The day on which the radio emission at these frequencies occured was designated as the zero day. Only the radio emissions which occurred in connection with the selected 23 active regions were studied.

The average daily values of the AE-index were plotted for the ten days preceding and the 12 days following the zero day. The separate emission classes (A - C, Class D was not treated on its own due to the small number of cases) were investigated separately for the cases in which the daily values of the AE-index increased following a radio emission in the corona, as well as for all the other cases (including sector boundary crossings of the interplanetary magnetic field). The same applies to all the classes combined (inclusive of Class D). It was found that the average daily values of the AE index increased on the sixth day following the radio emission in the corona in nearly all the cases (Fig. 4). A significant increase in the average values of the AE-index also appeared on the minus 1st to minus 3rd days, which is apparently associated with the preceding flare activity, or the boundaries of coronal voids. For the distant corona to be able to radiate intensively in the decametre range under simultaneous high flare activity, it is necessary that the corona be brought already earlier into a state capable of generating the emission. This condition could be created by the passage and trapping of

particles, extracted by magnetic structures, or even by processes generated by wave disturbances on the Sun, which display rapid development in the magnetosphere of the circumpolar regions.

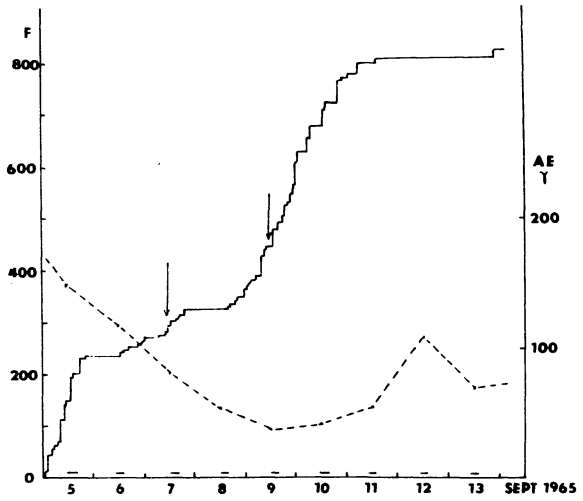

Fig. 1. Summation curve of flare activity of active region McM 7971, a typical representative of the cases in which the average daily-values of the AE-index increased after a radio emission in the corona. The minus sign with the day designation indicates the polarity of the interplanetary magnetic field. The arrow indicates the occurence of the coronal radio emission. The solid line is the summation curve of flare index F, the dashed line represents the variation of the average daily values of the AE-index.

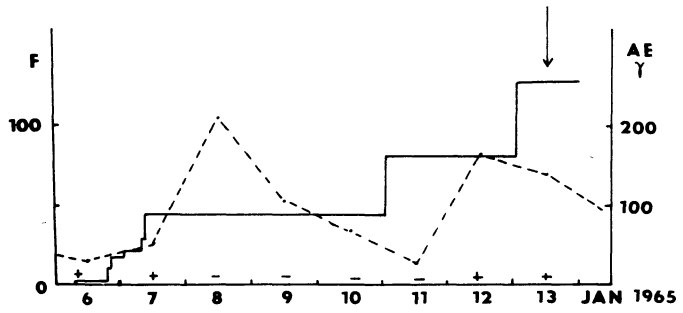

Fig. 2. Summation curve of flare activity of active region McM 7630; solid line; average daily values of the AE-index, dashed line; the + and - signs indicate the interplanetary magnetic field polarity; the arrow indicates the

occurrence of the coronal radio emission. This is a typical case in which the changes in the average daily values of the AE-index are probably caused by the change in the interplanetary magnetic field polarity.

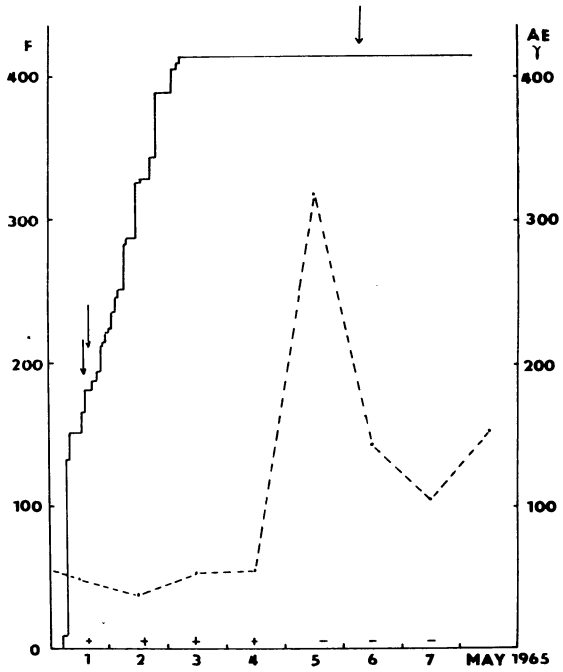

Fig. 3. Summation curve of flare activity of active region McM 7794, solid line; average daily values of the AE-index, dashed line; the plus and minus signs with the day designations indicate the interplanetary magnetic field polarity; the arrows indicate the occurrence of coronal radio emission. Typical case in which it is difficult to decide which of the two processes is responsible for the change in the average daily values of the AE-index.

Fig. 4. Curve of average daily values of the AE-index 10 days before and 12 days after a coronal radio emission on 29 and 33 MHz, derived from the 23 selected active regions which passed across the Sun idependently during the 20th solar activity cycle: a) Class A, b) Class B, c) Class C, d) all classes combined. The l.h. axis shows the AE-index values in units of gamma. The histogram shows the number frequency of the maximum average daily values of the AE-index for the individual days - scale on the r.h.s.

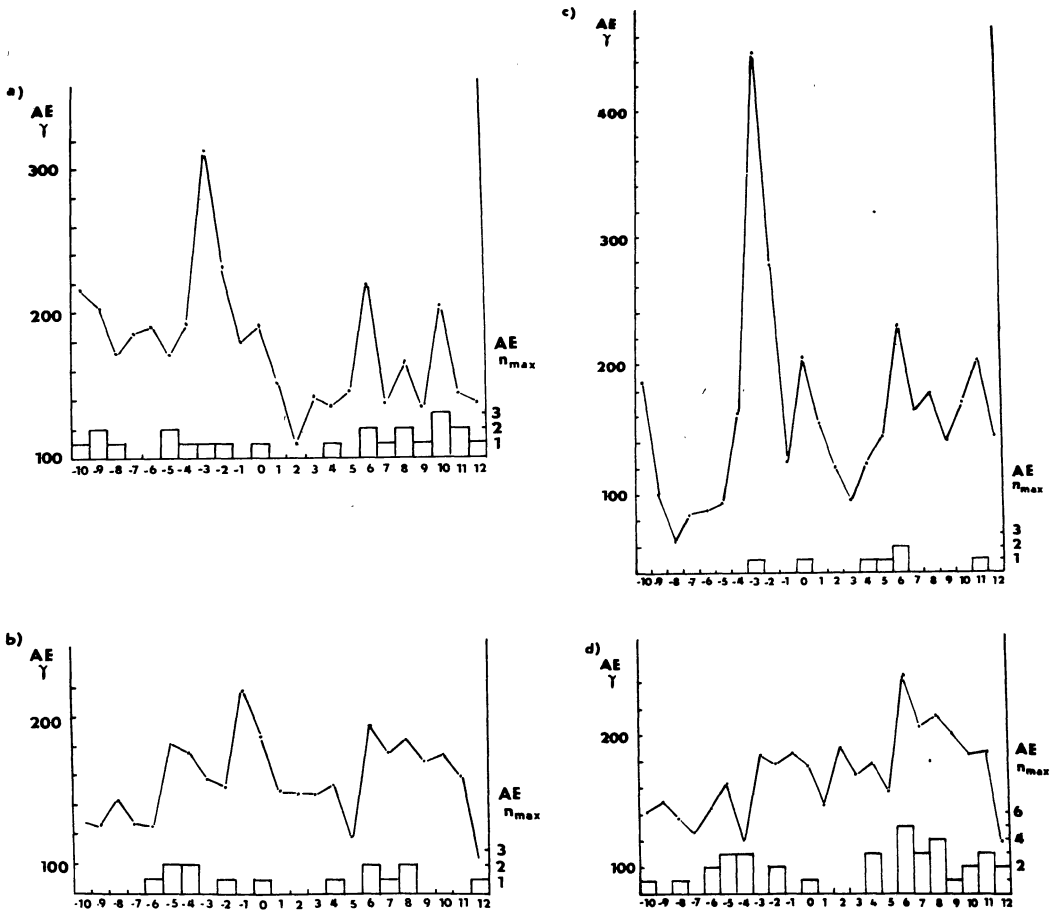

Fig. 4.

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