"Physics of Auroral Phenomena", Proc. XXI Annual Seminar, Apatity, pp.39-41, 1998

Polar Geophysical Institute

A RELATION BETWEEN MAGNETIC STORM INTENSITY AND FREQUENCY OF MINUTE INTENSIFICATIONS IN THE AURORAL ZONE

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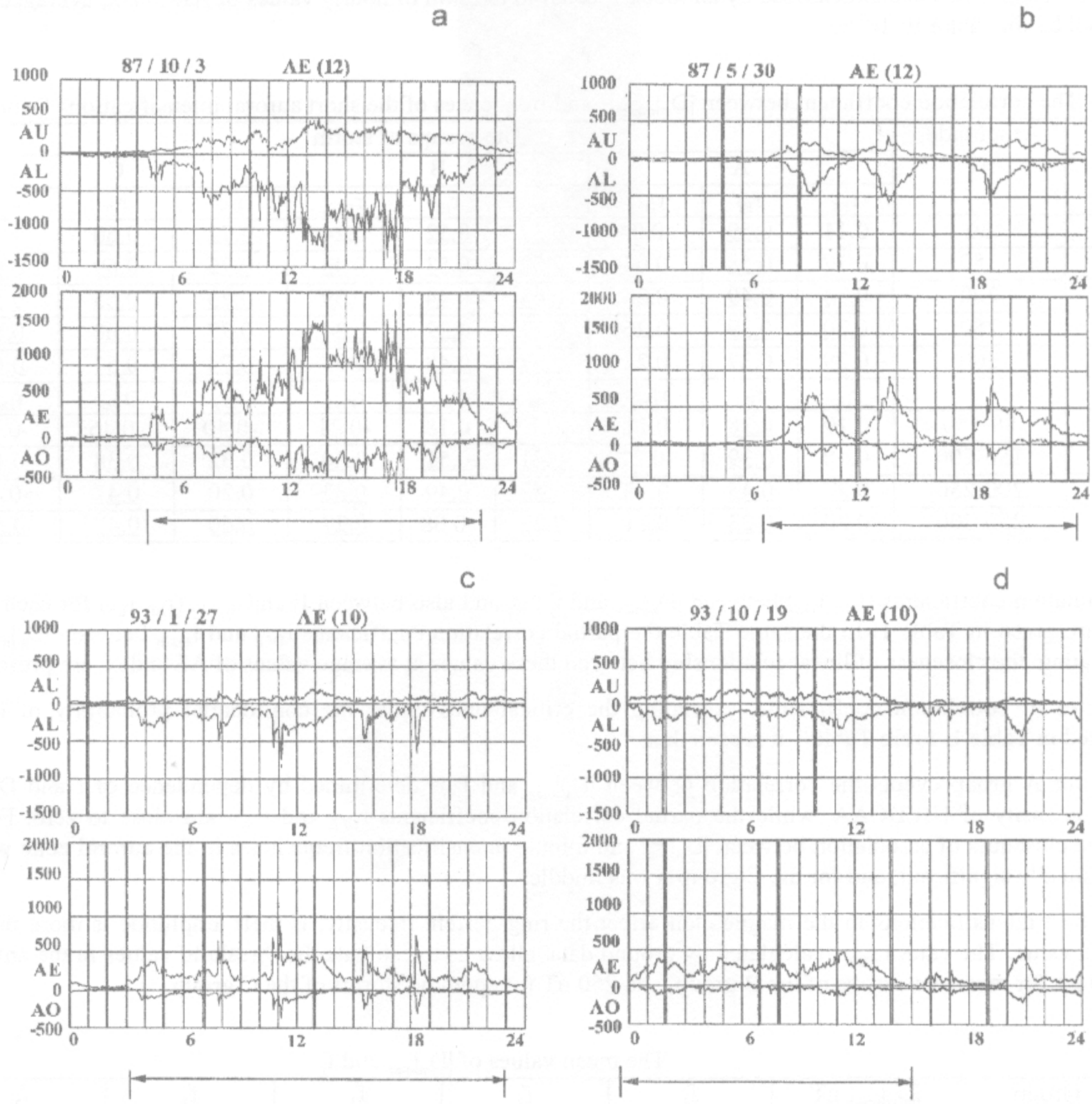
In [*Gelberg et al.*, 1998a] a classification method of high-intensity long-duration continuous auroral activity (HILDCAA) by means of the discriminant analysis was suggested.

Visually the separation of HILDCAA into types was performed by the envelope form of AU, AL, AE-indices, the modulation depth of the AE-index, the presence or absence of high-frequency (with a period of several minutes) and long-period (more than 3 hours) variations of AE.

The formalized classification by means of the discriminant analysis was carried out by 1 min values of AE using four parameters: N, which characterizes the frequency of appearance of short-period intensifications, B - the modulation depth of AE(t), C - the total degree of AE breaking, T - the indicator of deep decays in the disturbance intensity.

The Figure presents examples of variations of the auroral indices in the periods of different types of HILDCAA.



Variations of the auroral indices in the periods of HILDCAA (the arrows denote a duration of HILDCAA).
Types: a-1, b-2, c-3, d-4.

In [*Gelberg et al.*, 1998b] it is shown that in the auroral zone in 86% of recurrent storm events in the period of their expansion phase the HILDCAA of the third type has been observed. In 40% of the events, the third type of HILDCAA continued through the expansion phase. These events were separated into a group A of recurrent storms. In 46% of the events (B group), the third type of HILDCAA was transformed to other types. In the periods of the expansion phase of sporadic storms, in 75% of events the HILDCAA of the first type has been observed. These events form the group C. For each event of A, B, C groups, the frequencies of substorm appearance (F) and intensifications (f_j) of duration less than 10 min and of deviations of AE - index values from background level by δ_j=80, 150, 200, 250 and 300 nT have been found. For all the groups of the events $|D_{st}|_{max}$ was found not correlate with F. The correlation of $|D_{st}|_{max}$ with f_j was weak for the group A, moderate for B and close for C.

The purpose of this work is further analysis of relationship between the intensity of storms and frequency of short-duration auroral disturbances. The analysis has been performed for the events of the A (n_A = 47), B (n_B = 55), C (n_C =31) groups of recurrent and sporadic storms. For each event, by 1-min values of AE-indices the number of short (less than 10 min) intensifications, N_j, of the amplitude more than δ_j, was determined which were observed during Δt corresponding to the duration of the substorm expansion phase. By values N_j, the $M_j=N_j-N_{j+1}$ (j=1,2,3,4) were found which yield the number of short impulses in AE(t) with amplitudes $\delta_{j+1} < \delta < \delta_j$ registered in the auroral zone during Δt. The frequences f_j and φ_j were calculated by multiplying N_j and M_j by the factor $10/\Delta t$, where Δt is in hours. The intensity of HILDCAA is characterized by an index E equal to the sum of hourly values of AE-index, averaged over Δt, multiplied by the factor of $10/\Delta t$.

Table 1

The correlation coefficient between $|D_{st}|_{max}$, E and frequences of the short auroral intensifications f_j and φ_j

	Amplitude, nT	The groups of storm								
		A			B			C		
		r_{Df}	r_{Ef}	$r_{Df.E}$	r_{Df}	r_{Ef}	$r_{Df.E}$	r_{Df}	r_{Ef}	$r_{Df.E}$
f_1	80	0.11	0.59	-0.04	0.37	0.52	0.24	0.72	0.60	0.57
f_2	150	0.17	0.58	0.04	0.52	0.53	0.43	0.75	0.69	0.60
f_3	200	0.34	0.49	0.26	0.48	0.44	0.39	0.73	0.65	0.57
f_4	250	0.30	0.39	0.26	0.41	0.32	0.34	0.77	0.60	0.65
f_5	300	0.29	0.37	0.22	0.37	0.48	0.25	0.74	0.57	0.61
		$r_{D\varphi}$	$r_{E\varphi}$	$r_{D\varphi.E}$	$r_{D\varphi}$	$r_{E\varphi}$	$r_{D\varphi.E}$	$r_{D\varphi}$	$r_{E\varphi}$	$r_{D\varphi.E}$
φ_1	80-150	0.19	0.38	0.11	-0.13	0.18	-0.21	-0.40	-0.46	-0.19
φ_2	150-200	0.10	0.39	-0.21	0.41	0.51	0.30	0.32	0.38	0.13
φ_3	200-250	0.27	0.45	0.18	0.43	0.49	0.33	0.20	0.47	-0.10
φ_4	250-300	0.20	0.23	0.11	0.23	-0.08	0.27	0.60	0.47	0.56

Pair correlation coefficients (r_{Df}, $r_{D\varphi}$) between $|D_{st}|_{max}$ and f_j , φ_j and also between E and f_j, φ_j (r_{Ef}, $r_{E\varphi}$) for each event of groups are given in Table 1. In the same Table the partial correlation coefficients $r_{Df.E}$ and $r_{D\varphi.E}$ between $|D_{st}|_{max}$ and f_j, φ_j, indicating the closeness of linear relationship between these values at average values of AE-index, are presented.

The values of correlation coefficients, exceeding the critical ones under the confidential probability of 0,95, are underlined in Table 1. From Table 1 it is seen that:

1. Only for A group events the correlation between $|D_{st}|_{max}$ and f_j is determined by dependence of f and D_{st} on the average intensity of HILDCAA, while the partial correlation coefficients $r_{Df.E}$ and $r_{D\varphi.E}$ are close to zero. For the B group the closeness of association between $|D_{st}|_{max}$ and minute intensification frequencies in the auroral zone was weak but statistically significant, and for the C group it was middle.

2. The short intensifications in the magnetotail affect the ring current intensity, if their amplitude is more than some threshold value. The values $r_{D\varphi.}$, calculated by ground data, allow us to estimate the threshold values in the amplitudes δ as 150 nT for recurrent storms of the B group, and 250 nT for sporadic storms of the C group.

Table 2

The mean values of $|D_{st}|_{max}$ and f_j

Group	$|D_{st}|_{max}$, nT	f_1	f_2	f_3	f_4	f_5
A	46	11.9	3.9	2.0	1.1	0.6
B	66	21.0	10.8	6.4	4.0	2.8
C	104	25.3	14.7	10.4	7.5	5.1

In Table 2 the mean values of $|D_{st}|_{max}$ and f_j for the A, B, C groups are listed. Values f_j are in units of intensification numbers over 10 hours. The values f_j, for which $r_{D\varphi}$ is statistically significant, are underlined. From Table 2 it is evident that there is a threshold of minute auroral intensification frequency below which they don't affect the ring current. For the above selection the threshold value of f_j is equal to 4.

The relation between the ring current intensity and minute intensification frequency can be explained according to a scenario [*Mauk and Meng*, 1987], in which the inductive electric fields at the magnetospheric equator influence the transport of the energetic ions from the near magnetotail region into the stable trapping region. In [*Maynard et al.*, 1996] it was shown that under rapid changes of the magnetic field, the impulse amplitudes of the inductive electric field at the magnetosphere equator reach 10 mV/m. Apparently, short intensifications of magnetospheric activity with a large amplitude δ are capable to induce the electric fields of high intensity, controlling a transport of energetic ions to the Earth.

References

Gelberg M.G., Kershengolz S.Z., Sharaeva S.V. A classification of the long auroral disturbances, *Geomagnetism and Aeronomiya*, 1998a, (in print)

Gelberg M.G., Kershengolz S.Z., Shadrina L.P., Sharaeva S.V. Relationship between the classes of geomagnetic storms and auroral geomagnetic disturbances, *Geomagnetism and Aeronomiya*, 1998b, (in print)

Mauk B.H., Meng C.I. Plasma injection during substorm, *Phys. Scripta*. 1987. V. 18. P. 128.

Maynard N.C., Baker W.J., Basiuska E.M. et. al. Dynamics of the inner magnetosphere near time of substorm onset, *J. Geophys. Res*. 1996. V. 101. P. 7705.