

BREAKUPS OF DIFFERENT INTENSITIES AND HISS-TYPE VLF EMISSIONS

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Introduction

Auroral breakups may be of different intensities according to their temporal and spatial scale and strength of magnetic disturbance. Depending on scale size and the consequences breakups may be divided into ordinary ones and pseudobreakups or "local substorms" or "local auroral flares" (see [Koskinen *et al.*, 1993] and ref. therein). Pseudobreakups look like ordinary breakups but do not lead to a full-scale substorm expansive phase. Recently a lot of papers devoted pseudobreakups investigation have appeared (for example, [Koskinen *et al.*, 1993; Nakamura *et al.*, 1994; Pulkkinen *et al.*, 1998] and ref. therein). The authors of these works note that pseudobreakups exhibit most of standard signatures of substorm expansive phase both in the ionosphere and near-Earth plasma sheet, i.e. fading of auroral arc luminosity before breakup onset, brightening and activation of an auroral arc, a burst of Pi2 micropulsations, a weak enhancement of the westward electrojet, particle injection, local dipolarization, field-aligned current intensification.

A detailed comparison of different parameters before pseudobreakups and substorm expansive phase onsets shows that in spite of differences in their scale sizes, amount of output energy and recurrence of the intensification, there seems to be no difference in the physical mechanisms triggering pseudobreakup and ordinary breakup.

Relationship between VLF-emissions and aurora has been investigated in many works, (see [Raspopov and Kleimenova, 1997] for ref.). It should be noted, however, that the connection of VLF-emissions with breakups and pseudobreakups has not been studied. The purpose of our paper is to compare measured parameters of VLF-emissions with auroral breakups of different strength observed by TV.

Experimental data

In this study we have used TV auroral data and VLF-emission data synchronously recorded by video tape recorder during the Russian-Finnish observational campaign in 1993-1997 at the three stations: Porojarvi ($\varphi' = 65.64^\circ$, $\lambda' = 105.85^\circ$), Kalkkoiarvi ($\varphi' = 65.5^\circ$, $\lambda' = 105.4^\circ$) and Lovozero ($\varphi' = 64.07^\circ$, $\lambda' = 114.7^\circ$). TV auroral data have been analyzed by computer using the framegrabber video card, VLF data - by the ADC card and spectrum analyser. The output data have been presented as color or grey scale two dimensional pictures. About 100 hours of records during breakups of different intensity have been analyzed and processed.

Fig. 1 shows a typical example of auroral dynamics observed in the course of the substorm development on 15 November 1993 at Porojarvi. Fig. 1a represents dynamic spectra of VLF-emissions in the range of 0.2-5 kHz. Fig. 1b is an auroragram in the direction north - south (north is on the top). The vertical scale is unlinear, "0" in the center of the vertical scale marks the zenith of Porojarvi station. Intensities of aurora and VLF-emissions are shown in arbitrary units as different tints of grey colour according to the grade of scale on the left. As it is seen from Fig. 1b the first breakup began at southern horizon at 19.02 UT and expanded poleward by ~ 400 km. An intensive flash of VLF-hiss was registered (Fig. 1a) simultaneously with the breakup onset. During the second breakup started at 19.22 UT VLF-hiss was less intensive. VLF-hiss variations in two frequency ranges during the first breakup are given in Fig. 1c, riometer data for the same time period being presented in Fig. 1d. A riometer bay at Kilpisjarvi station (the nearest one to Porojarvi) began at 19.04 UT, 2 minutes after the first breakup onset.

An example of analogous data for a pseudobreakup occurred on 17 November 1995 at Porojarvi is shown in Fig. 2. The weak auroral activation looks very much like a pseudobreakup which began at 20.02 UT. The poleward expansion was about 100 km (see Fig. 2b,c). The vertical scale is given in degrees of zenith angle. As it is seen from the VLF dynamic spectra and integral curve of VLF-hiss (Fig. 2a,d) there is no hiss during brightening of an auroral arc with no significant riometer absorption being detected for the pseudobreakup on the contrary to ordinary breakups (Fig. 2e). Magnetic disturbance was also absent.

15 nov. 1993. Porojarvi.

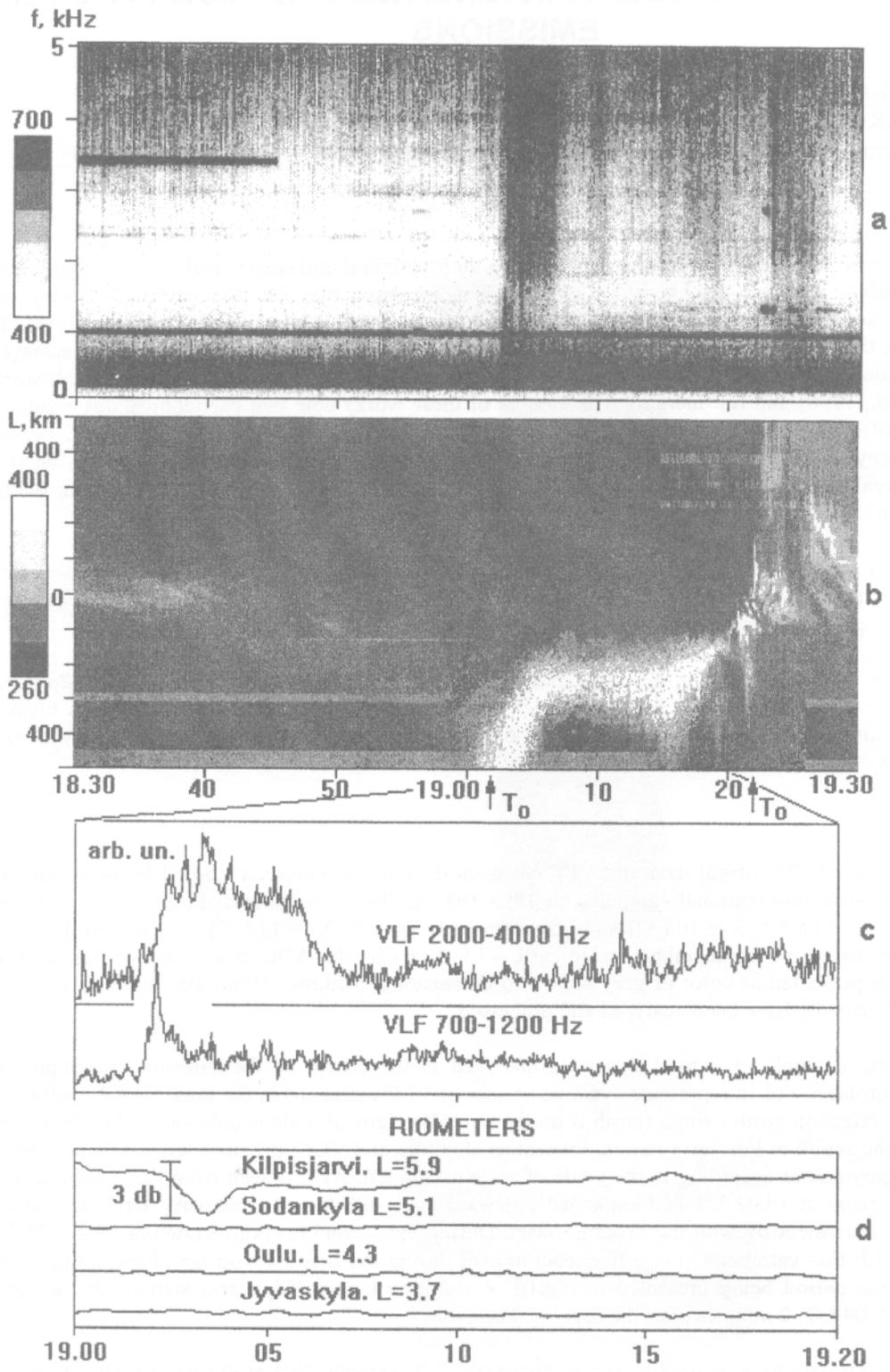


Fig. 1

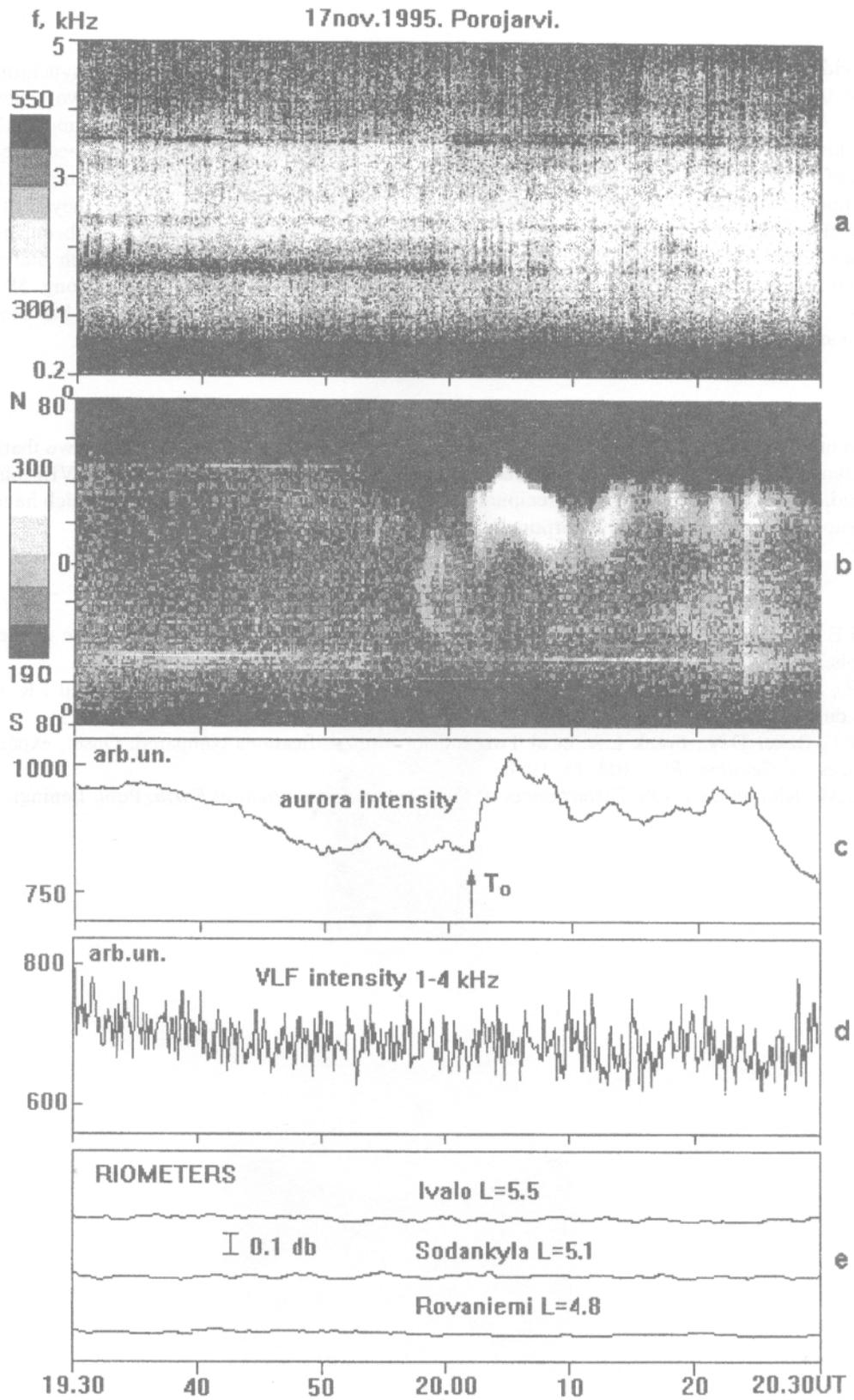


Fig. 2

Analysis of video records of 58 breakups of different strength and magnetic disturbance with synchronous VLF data in the range of 0.2-5 kHz and data on riometric absorption has shown, that breakups of two types can be clearly distinguished. Onsets of the first type correlate with appearance of intensive VLF-hiss, though detailed temporal structure of hiss not always repeats flashes of auroral arc. No hiss was detected for the second type of breakups. Comparison of some breakup characteristics such as an amplitude of magnetic perturbation, temporal and spatial scale, etc., has demonstrated that the breakups correlating with VLF-hiss are ordinary ones, i.e. they lead to the full-scale substorm development, while the second type are pseudobreakups. Using riometer data it has been shown that the hiss correlating breakups are accompanied by a significant ionospheric absorption (1-3 db) which indicates high energy particle precipitation. No absorption has been found for the second type breakups. Among 58 breakups under consideration 23 have been found to be ordinary ones and 28 pseudobreakups. This regularity has been observed in 20 cases of ordinary breakups and in 26 cases of pseudobreakups.

Conclusion

Investigation of the relationship between breakups of different intensities and VLF-hiss has shown that there are two types of breakups. The first type looks like ordinary breakups and is accompanied by intensive VLF-hiss and riometric absorption indicating high energy particle precipitation. During breakups of the second type which have signatures of pseudobreakups no hiss and riometric absorption have been found.

References

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